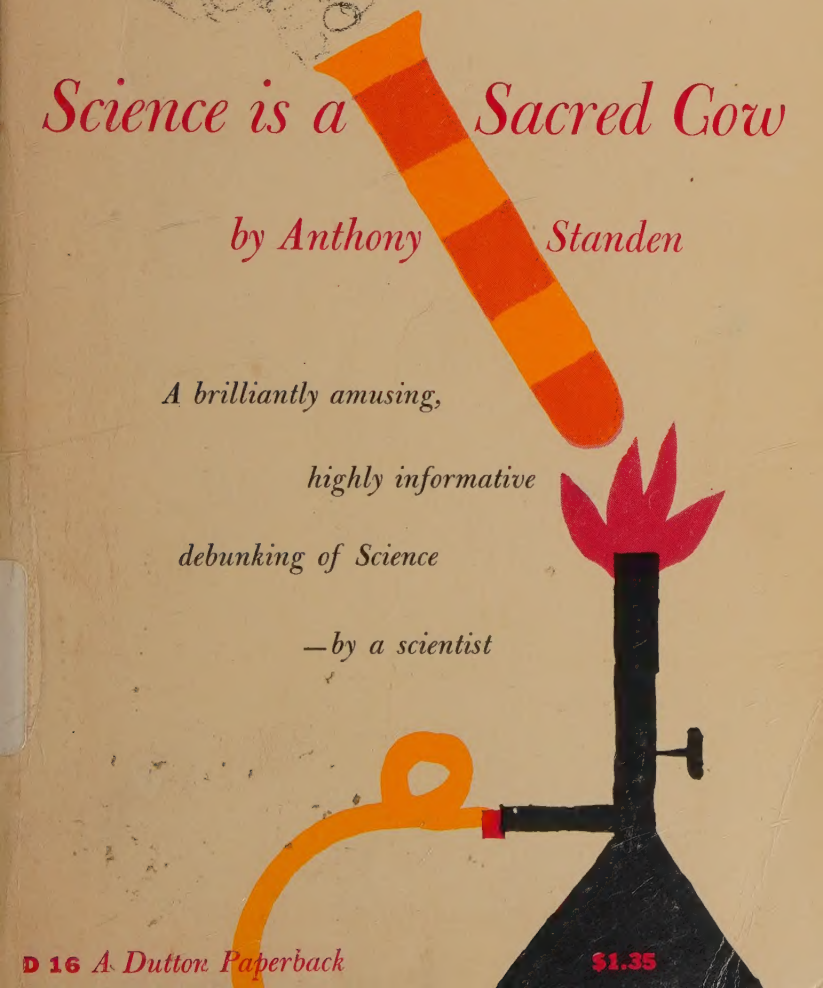
Science is a Sacred Cow

by Anthony Standen

A brilliantly amusing, highly informative debunking of Science —by a scientist



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To

FRANCES PHILLIPS

a humanist and not a scientist

ANTHONY STANDEN was born in England, and he graduated from Oxford University with a First Class Honors degree in Chemistry. This was followed by Chemical Engineering at the Massachusetts Institute of Technology. From 1930 to 1939 he was a chemist with Imperial Chemical Industries. Mr. Standen was on the faculty of St. John's College, Annapolis, Md. from 1942 to 1946 and is now with Interscience Publishers as assistant editor of the *Encyclopedia of Chemical Technology*.

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The Long Island Rail Road afforded me plenty of time for writing this book. The more the train was delayed, the more time I had to write.

SCIENCE IS A SACRED COW

Chapter I

THEY SAY IT'S WONDERFUL

When a white-robed scientist, momentarily looking away from his microscope or his cyclotron, makes some pronouncement for the general public, he may not be understood, but at least he is certain to be believed. No one ever doubts what is said by a scientist. Statesmen, industrialists, ministers of religion, civic leaders, philosophers, all are questioned and criticized, but scientists — never. Scientists are exalted beings who stand at the very topmost pinnacle of popular prestige, for they have the monopoly of the formula "It has been scientifically proved . . ." which appears to rule out all possibility of disagreement.

Thus the world is divided into Scientists, who practice the art of infallibility, and non-scientists, sometimes contemptuously called "laymen," who are taken in by it. The laymen see the prodigious things that science has done, and they are impressed and overawed. Einstein said that matter could be con-

verted into energy, and the atomic scientists went ahead and did it with the atomic bomb, and what other group of people have done anything so wonderful as that? Science has achieved so many things, and has been right so many times, that it is hard to believe that it can be wrong in anything, particularly for a layman, who does not have enough knowledge of the subject to be able to argue back. He might not even want to argue back, for the claims of science are extremely inviting. The benefits we have received from it are tremendous, all the way from television to penicillin, and there is no reason to suppose that they will stop. Cancer may be cured tomorrow, or the day after, and the nuclear physicists may easily find a way to end all drudgery and usher in the golden age. Mere laymen, their imaginations stupefied by these wonders, are duly humble, and regard the scientists as lofty and impeccable human beings.

"The scientist is a man of integrity and faith who trusts the basic laws of nature and intelligence to lead him into the paths of truth. His loyalty to truth is unquestioned: his capacity for patient and sacrificial inquiry is limited only by his powers of endurance; his devotion to the scientific method is unwavering; his objective is the welfare of mankind; and his discoveries, whether of medicine, mechanics, psychology, or what not, are the free possession of demo-

cratic peoples."* This is the opinion of Mr. Stewart Cole, in *Liberal Education in a Democracy,* and is probably a fair sample of what many laymen suppose to be true, although if scientists had to be all that Mr. Cole has been led to believe, there would be very few scientists.

Since it is only human nature to accept such flattery, the scientists accept the laymen's opinion about themselves. The laymen, on the other hand, get their information about scientists from the scientists, and so the whole thing goes round and round like the whip at Coney Island. Not that scientists become individually conceited about it; they will assure you, usually with truth, that they are modest and even diffident men. They take the extravagant praise as referring to Science in general, of which they are the humble representatives. But they themselves would be the first to say that Science is just an abstraction, and that to praise Science is to praise scientists, and so these individually humble men have their collective ego as inflated as a well-managed piece of bubble gum, while the laymen accept their own inferior status with scarcely a whimper.

The scientists are convinced that they, as scientists, possess a number of very admirable human qualities, such as accuracy, observation, reasoning

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power, intellectual curiosity, tolerance and even humility. Furthermore, they suppose that these qualities can be imparted to other people, to a certain extent, by teaching them science. In science teachers, therefore, the natural arrogance of scientists (collective arrogance, be it said, once and for all) is enhanced, for they think of teaching as preaching. They expound their subject in a spirit of high missionary zeal, hoping that some of the virtues, which they believe to be theirs, will seep into their pupils by osmosis. Teachers are therefore the propagandists, the front men, of science, and we can find out most easily what science is really like by paying close attention to what the scientists teach and the reasons they give for teaching it.

"The success of the scientific method . . . is based entirely upon an absolute honesty of mind and love of truth." This is what Professor Hendren, of the University of Georgia, Athens, Georgia, has to say, as one of the reasons why one should read his book on physics. "Dogmatic prejudice, lying, falsification of facts, and data, and willful fallacious reasoning are all out of harmony with the spirit of the sciences. It is writ large in the history of science that the most heinous offense a man can commit is to falsify his data and let his prejudice and his desires color his reasoning. It has never been given to such a type of

mind to discover any of the important truths of nature. If a student leaves his course in physical science with the typical scientific point of view, he has obtained a moral value which will be a distinct asset and which will help to lead him to a happy and successful life."*

If this is the effect of studying science in Georgia, it does not seem to be apparent in the rest of the population. Vast masses of people, all of whom had "Biology I" in college, or at least "Introductory Science" in high school, are not in the least distinguished, either by absolute honesty of mind, or by the absence of dogmatic prejudice, nor are they particularly happy or successful. How did this happen? Weren't they taught enough science? Or were they taught so badly that it didn't stick? Or can it possibly be that science — at any rate the kind of science they were taught — isn't all it is cracked up to be?

Almost everyone with a high-school education or more has been exposed to just a little science; most college graduates devoted a considerable fraction of their time to this highly-rated human activity, whether they liked it or not. They come out of the mill with one out of about three possible reactions: either (1) they hated it, and have depressing memo-

* Hendren: *Survey of Elementary Physics* (Athens, Georgia: The University of Georgia Press). Reprinted by permission.

ries of cutting up dogfish and of "doing" experiments and trying to make the result come out right, or (2) they found the subject interesting, but the teacher dull, and nourish for the rest of their lives a wistful yearning to know more, or (3) they gobble up everything, and suppose that because science has penetrated the structure of the atom it can solve all the problems of the universe. People in the first two categories are genuine, understandable human beings. But the third class! So far are they from having learned any humility, they are known in every high school and among the freshmen and sophomores of every college as the most insufferable, cocksure know-it-alls. If they go on to be professional scientists, their sharp corners are rubbed down, but they undergo no fundamental change. They most decidedly are not set apart from the others by their integrity and faith, and their patient humility in front of the facts of Nature, as their teachers would like to have us believe. They know the last word about the electron, and they seem to think that they are entitled to pour scorn on other subjects from a very great height. If you want to talk to them about poetry, they are likely to reply that the "emotive response" to poetry is only a conditioned reflex, depending on the associations established for various words, and that the thing to study is thermodynam-

ics. They become technocrats. They propose to solve the problem of war by having a committee of sociologists apply the scientific method to the differences between nations. They eat concentrated vitamins. They psychoanalyze every remark you make until it has no meaning. They are uneducated, in the fullest sense of the word, and they certainly are no advertisement for the claims of the science teachers.

That there are plenty of *good* reasons for knowing something about science goes without saying. Its practical advantages are perfectly obvious. Everybody knows how useful science is, in anything that you may do, from farming to mending a Ford car, and it would be very hard to find anybody who does not realize this, without any high-powered propaganda from the science-mongers. What is needed, in this very practical way, is just plain information without any high talk — as much as possible of the know-how of the television sets and dishwashing machines and plastic thingummies and gimmicks that are supposed to simplify our modern lives. The more of this kind of information everybody has the better, but it is only those who dish it out that are fooled into thinking that it has anything to do with moral values and patient sacrificial inquiry.

Atomic energy, of course, has given a great boost to science education, for persons of all ages from five

to 100. Children play atomic bomb in their games, and grownups flock to books and magazine articles trying to make clear to them the meaning of $E=mc^2$. There was even a time, shortly after Hiroshima, when the seriousness of atomic energy was more or less appreciated, but it is very hard to go on living day after day, week after week, and keep in mind that the atomic bomb is not getting any less terrifying, but rather more so. $E=mc^2$ is dreadfully important. But this is not just another book about atomic energy, for that infernal discovery does not fundamentally change the picture, it only makes it very much sharper and more serious. Scientific warfare was bad enough as it was; it is at least 10,000 times worse now. We are forced to make decisions about atomic energy, or to let the decisions be made by our elected representatives. We, and our representatives, should know as much as we possibly can about uranium 238 and the neutrons. And it is troublesome, but true, that we would do far better to know more rather than less, and this would involve us all in a long stiff course in physics, for it is very little good having just a nodding acquaintance with a neutron.

But in spite of all these excellent reasons why everybody should study science in large-sized doses, the scientists stick to their attitude that the real reason is something else, something higher and

loftier altogether. They are like the Elizabethan poets, who would praise their mistress' eyes, nose, lips, neck, etc., and then say "but if you could see the virtue that dwells within her breast, you would find that even more delightful still." It is for no base utilitarian reasons that they invite the adult, and bully the young into their classrooms. And it is not the results of science that they advertise most; it is always the "scientific method" or the "scientific attitude," or a variety of other hidden mystical virtues. Useful facts are mere dross: it is this underlying method that purifies and refines the soul. "Science teaches us how to think straight, how to avoid deceit, and how to benefit mankind most by honoring the authority of Truth,"* says a chemist: a biologist goes in for "emotionalized standards"; one of these standards is believing in the scientific attitude with a fervent conviction "somewhat akin in its intensity to that of a religious belief."† He wants to teach the laws of health, to teach that nature is governed by law, and to make pupils love birds, trees, flowers, etc., and to give what he calls "a speaking acquaintance with plants and animals." Professor E. G. Spaulding, of Princeton, "considers the cultivation

* *Journal of Chemical Education* (La Jolla, Calif.), January 1947. Reprinted by permission.

† Downing: *An Introduction to the Teaching of Science* (Chicago: The University of Chicago Press). Reprinted by permission.

of scientific attitudes in the population at large of great importance as a means toward reconciling criticism and resistance to convention with amenableness to social requirements."* And so if you wish to achieve this reconciliation, whatever it is, you must get that scientific attitude. Mr. B. C. Gruenberg, an authority on the teaching of biology, favors science teaching "for enriching and stabilizing our thought in common," and says "continuous contact with the progress of science would serve to bridge the gap between older and younger, essential for family and social integration."† (The bridge is essential, not the gap.) Evenings, we should sit by the fire and chat about atomic fission. Another scientific educator believes that "scientists have a special responsibility to help adults and adolescents to find new conceptions and ideas to replace the traditional religious beliefs about the nature of the universe, man's place therein, and the meaning and value of human life, which science has made untenable"‡ (the traditional beliefs have been made untenable, not human life, for this was written in 1935, well before the atomic age). And Mr. Gerald Wendt, a noted science publicist, says: "The student and

* From *Science and the Public Mind,* by B. C. Gruenberg. Copyright 1935. Courtesy of McGraw-Hill Book Co., Inc.

† *Ibid.*

‡ *Ibid.*

the citizen need to absorb the scientific attitude, to master the scientific method of thought, and to understand the basic concepts of the sciences. Only thus, delving beneath the superficial and avoiding the burden of the technical, can they be ready to read further and to understand in the decades to come what science is doing and can do. Only thus can their own intelligence be called into play."* Merciful heavens! Were there no intelligent men before science was invented?

Alas, it isn't even true that scientists are always intelligent. Mr. Hilaire Belloc has pointed out that science has changed greatly, and for the worse, since it has become popular. Some hundred years ago, or more, only very unusual, highly original spirits were attracted to science at all; scientific work was therefore carried out by men of exceptional intelligence. Now, scientists are turned out by mass production in our universities, and they therefore include men of very ordinary, even mediocre intellectual powers. This is not to say that we shouldn't go on turning out scientists by mass production; their work is extremely useful, nay, indispensable: don't let us do anything to stop it. But we are having wool pulled over our eyes if we let ourselves be convinced

* Reprinted by permission from *Earth Sciences* by J. H. Bretz, published by John Wiley & Sons, Inc., 1940.

that scientists, taken as a group, are anything special in the way of brains. They are very ordinary professional men, and all they know is their own trade, just like all other professional men. There are some geniuses among them, just as there are mental giants in any other field of endeavor. There is a good-sized intermediate group, who are fairly intelligent along their own particular line, just as in the population at large there are plenty of people who are fairly intelligent in at least one line. And there is plenty of work, in science, that can be done by people who are stupid. For example, much agricultural research, which is roughly like this: it is necessary to find out what certain fertilizers will do, in varying amounts, by themselves and in combination. A large field is divided up into squares, which are treated with the various fertilizers in every possible combination, and the bushels of apples or pounds of potatoes are weighed. This requires nothing more than a certain amount of attention to detail. To find out the answer—which fertilizer is really the best — requires the use of some rather complicated mathematics. The proper mathematics was developed by intelligent men, but almost anybody can be trained to use it. This kind of work is by no means confined to agriculture. At a rough guess, fully 90 per cent of all the scientific papers published are of this sort, sometimes without

the mathematics, and they are just plain dull. And there is no reason why we should be hoodwinked into thinking that there are marvelous virtues in something that anyone can do, and that in any case is just plain dull.

If it isn't a 90 per cent yield of potatoes, it's something else. It all comes down to "correlations" (one of the scientists' favorite words). They measure two things, and find that when one of them changes the other also changes: this is called a beautiful correlation, and it is pursued with a solemn, dead-pan intensity, as if a correlation were a thing in itself. Very often they argue that the one thing *caused* the other, when it might quite well have been the other way round. Executives have been found to have a large vocabulary; therefore, learn ten new words every day, and you will become an executive. Or else, there will be an argument that, in principle, runs like this: a man gets drunk on Monday on whiskey and soda water; he gets drunk on Tuesday on brandy and soda water, and on Wednesday on gin and soda water. What caused his drunkenness? Obviously, the common factor, the soda water.

Scientists, themselves, are sober people. Their conventions and get-togethers are not nearly so exciting as those of salesmen. They know no more about subjects outside their own than any other

group of people do, perhaps less, for they are hard-working, and spend long hours in keeping up with all the papers that are published — the 90 per cent potatoes stuff. They relax occasionally, and have their own form of rather professorial humor. They easily absorb the prejudices of those around them, and many of them are mildly reactionary, and have mild class feelings and race bias, in an unthinking sort of way.

As we saw before scientists are individually humble, for the most part, particularly the very best scientists. Though collectively they are a society of mutual backslappers, not all of them go in actively for scientific evangelism. It is mostly the scientific educators that do, but the rest of them make no effort to control the ridiculous excesses of these hucksters, and they may be taken as condoning their proselytizing by their silence. After all, with such a list of virtues as Mr. Cole has strung together, who would go out of his way to deny such praise? And as advertising always convinces the sponsor even more than the public, the scientists become sold, and remain sold, on the idea that they have the Key to the Absolute, and that nothing will do for Mr. Average Citizen but to stuff himself full of electrons, protons, neutrons, neutrinos, genes, chromosomes, glands, hormones, potassium chloride, high-octane

gasoline, ultrasonic vibrations, and the theory of relativity.

What exactly is this "Science" that is so highly regarded? Buckets of ink have been used up in defining it, but the simplest way is to say "Science is any knowledge that is arrived at by the Scientific Method" — and then to define the scientific method. Many more buckets of ink have been used in explaining this method, but its essentials can be described rather easily, as a series of definite steps, roughly as follows. The first step is observation. Usually what is observed is the result of a deliberately contrived experiment (but not necessarily, for astronomy is a science, and it is impossible to do any experiments with the stars). A number of observations are collected, and then the scientist goes into a huddle with himself and forms a hypothesis, that is, a suggested explanation, of some sort or other, of the facts that have been observed. A hypothesis is, if you like, a sort of guess: later in this book some of the hypotheses of science will be described, to see how they work. In the next step the scientist says, "*If* my hypothesis is true, then when I do such and such an experiment, so and so ought to happen." The final step is to do the appropriate experiment, and see if the hypothesis is substantiated. If the result of the experiment is different from what was expected, the hypo-

thesis is rejected at once, it's wrong. If the experiment agrees, the hypothesis is accepted tentatively. As further experiments are done, perhaps by other scientists, the hypothesis is continually put to the test of experiment, and if it survives a large number of experiments, and can explain them all, it is promoted to a "theory." A theory is simply a well-tested hypothesis, but there is no sharp dividing line. Even the very best of theories may turn out to be wrong, for tomorrow an experiment may be done that flatly contradicts it. Scientists suppose that they always remember this faint shadow of doubt that hangs over all their theories, but in practice, as we shall see later, they often forget it.

Besides these essentials of the scientific method, there are some other qualities usually associated with science, and that are connoted if not denoted by the word. One of these is accuracy in observation, which quite clearly is necessary. Quantitative measurement is also very highly stressed. Even more highly regarded is the absence of bias, or freedom from prejudice, that scientists think they enjoy. In the higher realms of science it really is uncommonly difficult to be properly impartial when comparing two theories, your own and somebody else's, or to be sure, in making a hypothesis, to give the other fellow's results just as much weight as your own. Most scien-

tists do this remarkably fairly and well, in their own specialized fields, though whether they can practice this virtue outside their own little duck ponds is much more questionable; at any rate they pat themselves hard on the back for doing it at all. But they reserve the greatest praise for their own objectivity. It is continually stressed, in all scientific training, that subjective feelings must not enter. The scientist records the result of an experiment in terms of observations, usually readings of instruments; he pays no attention to whether he likes it or not. The objects in front of him are what he is talking about, not his own subjective feelings about them. He must record a result that contradicts his theory just as objectively as one that agrees with it. According to what some scientists say, one could almost define science as pure concentrated essence of objectivity. And this explains why science is, for some people, devoid of appeal, and why it leaves out much that is of interest to everybody, for we are all of us, as human beings but not as scientists, tremendously interested in our own subjective feelings.

Another belief firmly held by all scientists, even the quieter ones, is that they define their terms accurately, and express themselves with a praiseworthy precision which everybody should imitate. It is hard to see how they can keep up this belief, seeing

that all of them spend quite a lot of time in reading what is written by other scientists, and that clear expression is as rare among scientists as it is anywhere else. The answer to this puzzle can only be that scientists are no better readers than anybody else, and don't know clear writing when they see it. At any rate they spend a great deal of trouble in framing definitions for their words. Sometimes the definitions actually say what the words mean, sometimes they don't. But they are impressed with the advantages of this procedure, and they teach words, supposing that in so doing they are teaching science. They will have you call the mammals the "Mammalia," or the backboned animals "Vertebrata." They will teach you that a spider is not an insect, that a whale is not a fish, or sometimes, by a crazy mismanagement of words in the name of science, that a shark is not a fish (because it is not a bony fish). They will teach you that the Latin name of an animal or a plant is the "scientific" name, as if one knew anything about science simply through knowing Latin names, although the whole Linnaean system of names, they will freely admit, is in an appalling mess. They will teach you that "work" is "force times distance" instead of being anything you do that is disagreeable and that you get paid for. In the realm of higher abstractions they will teach

you powerful phrases like "electronic resonance" and "emergent evolution": they will define these in tight phrases which convey a meaning only to those who already understand it, and if you can produce, in an examination, the correct defining words, then you pass the test. And all this has as much, and no more, to do with real science as knowing the names of the pieces and the squares on a chessboard has to do with being able to play chess.

The dreadful cocksureness that is characteristic of scientists in bulk is not only quite foreign to the spirit of true science, it is not even justified by a superficial view. It is of course quite possible to write the history of science as one long crescendo, whose ultimate glorious achievement is the present—and what wonderful people we must be. It is always given in this way, in teaching, as part of a little introduction which is a pep talk for the particular science being dealt with. The Greeks were very clever people, the introduction will go, and they thought of many ingenious theories, but they were lazy, and did not do experiments with their hands. Their foremost philosopher was Aristotle, and it is now the fashion to say that he was not altogether too bad, but the medievals were bad who believed things on Authority, the authority of Aristotle. Modern Science began with Galileo and Newton, and has run steadily ahead

ever since, with a great acceleration of progress in the last fifty years, with radioactivity, the discovery of X rays, Einstein, Bohr, the structure of the atom, Oppenheimer, the Manhattan Project and the Atomic Energy Commission (leaving out the Un-American Activities Committee). But the same story can be told with a humiliating reverse English on it: if the climax and pinnacle of science is our knowledge of the atom *now,* then what was known ten years ago must have been decidedly imperfect, for science has made great strides since then. What was known twenty years ago was even more imperfect, and the science of fifty years ago hardly worth knowing. Using a little imagination, we can ask what will become of the science of today, some twenty or thirty years from now? Unless the rate of scientific advance shows a notable slacking off (and there are no signs of this) our best knowledge of today will become decidedly frowsy.

Since scientists have such overweening confidence in their own ability — in their collective ability, that is to say — it is small wonder that they make no attempt to teach what are the limitations of science, for they hardly recognize any.

Yet there may be limits to what science can do. Consider this question: Can science disprove ghosts? In the supremely confident period, toward the end

of the last century, when it was supposed that there was a conflict between Science and Religion, and Science was rapidly winning, it was the mark of an educated man to say "Science has proved that there are no such things as ghosts, they are merely the superstitions of the unenlightened." Education is always behind the times, and much the same attitude is prevalent today; you can still hear people say, "Surely, science has proved that there are no ghosts." And yet, is that so? Suppose, just suppose for the sake of argument, that ghosts can occasionally appear when the psychological conditions are just right, and suppose, what might quite well be true, that one necessary condition for the appearance of a ghost is the *absence* of a scientist: well then, "Science" (that is to say, scientists) would go on investigating ghost after ghost, and would "disprove" every one of them, and yet ghosts would continue to appear whenever the scientists were not looking.

This is a simple case, perhaps not a very important one, illustrating the impossibility of proving anything negative by the scientific method. At least it is enough to show that science is not infallible, and if science has any more serious defects than the inability to perceive an occasional spook in the corner, it is of the utmost importance that citizens, generally, should know what they are. Yet this sort of knowl-

edge is very conspicuously absent, from the populace at large, and from the curriculums of institutes of learning. Non-scientists don't even know what science *can* do; scientists are so obsessed with the past successes and future possibilities of their own specialty that they have no idea what the proper field of science in general is and no recognition that there are any limits. What they can't do, some other scientists, presumably, can do, so that they come to think that Science with a capital "S" — or rather its concentrated and distilled essence, the Scientific Method — is the universal cure-all for mankind.

They are wrong, for science is not a cure-all. The claims of the science fiends are preposterously exaggerated. Science has many important limitations, which will appear throughout this book in ever-increasing number. The idea that science is infallible and beyond criticism, is a delusion, and even a dangerous one. The teaching of science only perpetuates this delusion, for it is always taught by scientists, who are so busy keeping up with science that they can never look at it from the outside. What with scientists who are so deep in science that they cannot see it, and non-scientists who are too overawed to express an opinion, hardly anyone is able to recognize science for what it is, the great Sacred Cow of our time.

John Dewey, a worshiper in the temple of science, said "the future of our civilization depends on the widening spread and deepening hold of the scientific habit of mind." But perhaps there is more truth in an old wisecrack of Oliver Wendell Holmes: "Science is a good piece of furniture for a man to have in an upper chamber provided he has common sense on the ground floor."

Chapter II

HOW THEY DISH IT OUT

"EACH normal-minded man and woman needs to see the basic realities portrayed by chemistry, physics, geology, geography, physiography, meteorology, astronomy, biology, botany, zoology, human biology, psychology, sociology, economics, political science, and ethical science."* Thus Mr. Franklin Bobbitt, Professor Emeritus of the University of Chicago, who is so much in love with "ologies" that he even pads the list, for human biology is included in zoology, and both zoology and botany are included in biology. Also ethical science does not exist. But even allowing for duplications, there remain the names of twelve sciences, and it is certainly possible to meet plenty of men and women, fully up to the "normal-minded" standard, who don't see the basic realities of more than a very few of them, if any.

Undoubtedly if you try to learn, in the course of an education, something about twelve sciences, you will be spreading things very, very thin. But would it

* "The Educational Policies Commission Banishes Science," *The Scientific Monthly*, August, 1946. Reprinted by permission.

be better to tackle, say, only three sciences, and let the other nine go, hoping that the Spirit of Science would creep into you by osmosis? Or would it be better to concentrate on just one science and do something of a job on it? The science educators come slap up against this problem, and before we go through the sciences, one after another, in the following chapters, to see which comes nearest to possessing the mystical virtues claimed for the whole lot, we may as well see how, in practice, the science men deal with this difficult question, of whether to Spread It All Thin or Pick and Choose. For the professional science-ologists, the teachers, have a position which gives them tremendous influence over everybody, and it is through these people that we are pulled by the nose by scientists.

Pick and Choose has been the traditional system in American education for the last two generations or more, and the majority of people who are neither very old nor very young were exposed to it. You began each term by staring at an enormous list of "offerings," and decided whether the advantage of going to a notoriously lenient professor outweighed the disadvantage that he lectured at nine o'clock, and whether the boredom of a course in "animal husbandry" offset the convenience of rising at eleven and walking to a lecture room conveniently near the

fraternity house. Some people had "The Chemical Basis of Life," while others had Diesel Engineering. Some were taught to think straight by means of Abnormal Psychology, others to avoid deceit through The Story of The Rocks. It made no difference what the course was called, nor, within limits, what it was about; so long as it could possibly be described as Science, it was believed to have the same ennobling influence, even if it was Dairy Chemistry, Industrial Psychology, Personal Hygiene, Photography, Home Making, Practical Cookery, or Clothing Selection and Construction. And so far is this system from "stabilizing and enriching our thought in common," that it would seem to be designed on purpose to keep people apart from one another, by ensuring that no two people will ever have the same background of knowledge.

Pick and Choose started in a very mild way with President Eliot's Elective System, at Harvard in the 1870's. Even in those early days, the complexity of life had reached the point where so much specialized training was required for any profession that the time taken to acquire this training interfered with serious education. Eliot's bold stroke was to allow each student to choose a small number of courses which would actually help in his chosen profession. In its original mild form, the elective system was

probably excellent, and it helped to get away from a dry-as-dust curriculum of classics, studied for no better reason than the fact that they always had been studied. In later developments the system became a sort of auction, in which each department and each teacher vied with the others in developing the more thrilling "student appeal." "Motivated learning" was the watchword, because by that time the psychologists had actually discovered that people learn more easily if they are interested in what they are learning (or, as they would express it, "success in learning is largely determined by emotionally-toned drives"). The scientists made their appeal exceedingly practical, supposing, what is not necessarily true at all, that a course in Scientific Appliances in the Home will attract more students than Elizabethan Drama, because you can put it to some simple and immediate use. "The application of the scientific method in life situations," or some such pretentious phrase, would be the justification for this. Thermodynamics would be dropped, although it is extremely scientific, and a more practical course would be given, such as "Consumer Science," as if science were any different for a consumer than for a producer. Diesel Engineering, or Air Conditioning, would be taught, not only as ways to make a living, but in the name of education, as if the fact of studying these subjects on an ivy-

covered campus, in imitation colonial buildings, instead of in the workshops where they are practiced, would teach someone not only how to make a living, but what to do with his living when he has made it.

Alas, such "practical" training, without sufficient theory behind it, isn't even practical. Lenin said, "There can be no revolutionary practice without revolutionary theory," and this is as true of anything scientific as it is of revolutions. A "practical" course in radar or electronics teaches you which wire to connect to which, or which knob to turn when something goes wrong: it doesn't give any genuine understanding of electrons, or of the scientific method whereby electrons were discovered, because this requires learning some stiff mathematics first. At best, it can only tell you about radar or electronics as they are now, and since education is usually twenty years out of date, it will probably tell you something that is already frowsy. Twenty years from now it will be useless. Suppose someone had a "practical" course in radio twenty years ago, according to ideas that were old-fashioned even then: he will have heard that there are batteries, a cat's whisker, and a crystal. Along come tubes and the "all-electric" set, and the batteries go out the window. Along comes frequency modulation, and he cannot understand these new vibrations (he never did understand what vibrations

are, or what it is that "vibrates"). Along comes radar, and he is already completely stumped while television is more complicated still. Tomorrow brings some even more fundamental change, and there is nothing for it but to go back to school, and learn some of the theoretical science that should have been explained twenty years ago.

One big reason for the popularity of Pick and Choose is the great appeal it has for college presidents, because it is such a beautiful way to pad the curriculum. Instead of just one or two or three simple courses, a long list can be drawn up; the department of chemistry will split off a department of chemical engineering, physics will be offering nucleonics for everyone, astronomy will be a little department of its own, and biology will first split into botany and zoology, and then will burgeon forth as bacteriology, biometrics, ecology, endocrinology, taxonomy, zoogeography and perhaps paleobotany. This of course is Prexy's Dream. What a highly developed college this appears to be, on reading the program! What a remarkably varied, yet well-balanced list of "offerings"! And yet this well-balanced appearance is in the program only, that is, in the mind of Prexy. No one person ever gets all of these courses, but only a little bit here and a little bit there. No matter! The board of governors can easily be convinced that

such scraps of information, when averaged over the entire alumni, will add up to a real education, even though some of the graduates can only read *The National Geographic Magazine* and others can only read *The Wall Street Journal.*

The great days of the Pick and Choose system are probably over, for education, like everything else, goes in fads, and has the normal human tendency to put up with something bad for just so long, and then rush to the other extreme. Under the elective system science was broken up into tinier and even tinier little bits. On the rebound it has been put together into even larger units than ever before. The result is called a Survey Course, meaning that it bounces airily over a huge range of subjects, without coming down to earth much. Survey Courses were started about thirty years ago, and their popularity has increased, and is probably still increasing. They amount to the principle of Spread It All Thin. Instead of studying botany (plants) or zoology (animals) separately, a Survey Course will take you in one year over the whole of biology, which is botany and zoology combined, and it will claim to present "the basic realities portrayed by" all the subsidiary sciences, from bacteriology to zoogeography. A physics course was formerly just physics (and that in itself is a lifetime study), but a Survey Course in

physics will pile astronomy and geology on top. Not content with that, a Survey Course will often throw in chemistry, which is a vast subject comparable in size with physics, so as to be able to give a dazzling panorama of everything from the atom clear on up to the most distant nebulae. The sun is 93,000,000 miles away — light from a nebula may take 100,000 years to reach us — the Paleozoic era lasted 350,000,000 years — a hydrogen atom is a ten millionth of a centimeter in diameter — there are more than 100,000 known compounds of carbon — under extremely high pressure ice can exist above O°C — plutonium is obtained by bombarding uranium 238 with slow neutrons — and all these facts have to be noted down and regurgitated in a quiz. They claim that this sort of thing is stimulating to the imagination, but it is piled on so thick that it is like being hit over the head with an intellectual bludgeon. There is no time for any accurate and precise habits of thought, the pace is far too breathless; no time for any meticulous and unbiased observation, only for being told that someone else made the proper observations; no time for actually practicing any of the scientific virtues at all, only for absorbing as many as possible, and forgetting as few as possible, of a terrific succession of facts facts facts. And yet there have occasionally appeared courses called

Introduction to Science, or something to that effect, which combine physics (all its branches) plus its attendant geology and astronomy, with chemistry and even biology with all its ramifications, and for good measure a little meteorology and "soil science" thrown in, to make what can only be described as a General Outline of Absolutely Everything, handed out painlessly in capsule form.

This then is the problem: Flit airily over a dozen different sciences, and the famous scientific method becomes so diluted as to be hardly recognizable; split it all up into little bits, and no one is able to have a clear look at the whole. It is all very well for the specialist — who is going to take the time to study his subject thoroughly — he will become a scientist himself, and will presumably develop the appropriate integrity, faith, loyalty to truth and capacity for patient and sacrificial inquiry. But how is it possible to indoctrinate these virtues into a person who does not have the time to make more than a very limited acquaintance with science? Indeed, is it possible at all?

The scientists, and the educators, have both reexamined this question very carefully, and although the conclusions they have reached are very much the same, they come to them by different paths.

When a scientist wants to find out why he should be teaching science (as he would put it, "to deter-

mine the objectives of science education") his way of setting about it is strange indeed. The Committee on the Function of Science in General Education (of the Commission on Secondary School Curriculum, Progressive Education Association, to complete its lengthy title) quotes the work of three high-school teachers in Colorado, who adopted a scientific attitude with regard to the purpose of their course in Functional Chemistry. "One of our first problems was that of discovering just what students could expect to get from a course in chemistry that would be valuable to them as a part of their general education. At the beginning of the experiment it was impossible to say with any exactness what such objectives should be. Over a period of several years students were asked what they thought chemistry might contribute that would be helpful to them. Their answers were tabulated, and those that occurred with some frequency were used in the organization of the course."* These chemists, being scientists, had to use some sort of an experiment to find out why they were teaching chemistry, and the "experiment" took the form of asking somebody. But they did not ask chemists, people who, from their own knowledge of chemistry, might have some idea of why chemistry is

* Thayer: *Science in General Education* (New York: Appleton-Century-Crofts, Inc.) © 1938. Reprinted by permission.

worth learning — if it is. No. They asked the students, who of course were students precisely because they did *not* know any chemistry, and therefore, to any normal-minded person, would be the last people who would know the answer to the question.

The students in this experiment, perhaps with some sly idea of "what teacher wanted," came out with a wonderful list of "objectives," such as "The study of chemistry should help me to develop the ability to investigate intelligently any individual problem which may be of interest to me," * and "This course would help me to develop understandings which will make it possible for me to select and use goods and services wisely." † They threw in "wholesome leisure-time activities," "proper habits of health," and a few others, and they particularly stressed the "habit of thinking scientifically," to the great gratification of the investigators, who said, "This objective was so all inclusive that it was found necessary to discover the characteristics of scientific thinking" ‡ — apparently also by asking the students! The habit of scientific thinking was found to include: suspension of judgment until all available significant facts have been ascertained and analyzed — learning

* *Ibid.*
† *Ibid.*
‡ *Ibid.*

to distinguish between prejudiced and unprejudiced opinions — demanding adequate evidence before settled conclusions are reached — relying upon tested results of reputable workers — insisting upon accuracy — being curious, observant, tolerant, broad-minded, and ready to act on the basis of tentative judgments, realizing that behind every result there is an adequate cause, and using the scientific method of solving problems. Thus these ingenious and tactful high-school students fed back to the scientists all the hackneyed haywire and hogwash that they (the scientists) wanted to have fed back to them.

Another such experiment, on graduates of a girls' college, gave milder results. It was made very sensibly *after* they had had the course (a rather special course in the history of scientific ideas) and not before. Most of their replies were in the conventional terms of "appreciation of the scientific method" and "understanding of the importance of methods of observation and of scientific honesty," but they added a new twist, for they reported a social value, saying that the course contributed to dinner-table conversation.

Occasionally the scientists themselves will add another inducement, called "learning about our environment." This is particularly emphasized by those who teach geology, or a recently invented hodge-

podge of studies called "earth science." Sometimes they add "physical environment," which is at least true and precise, but sometimes it is just "environment." "*We meet the environment*" is the first sentence of the first chapter of one of the textbooks, and it continues, "Bright islands with wooded hills, valley farms and villages! Encircling arms of blue salt water!"* The underlying idea is based on a saying that scientists like to trot out "Man is the product of his heredity and his environment." What they mean is that *a* man is the product of his heredity and his environment, for no one knows what the heredity of "man" is. (The Missing Link is still missing.) The statement is open to dispute, because a Calvinist, for example, would say that the fate of man depends upon predestination, which overrides any amount of heredity and environment; but then a predestinarian Calvinist is not a scientist, so what he says doesn't count, and the scientists have said to one another so often, "Man is the product of his heredity and his environment," that they all believe it without question.

But what is the "environment" of man? The place where he lives, clearly. Man lives on the surface of the earth, and he can descend a couple of miles or so, and go up perhaps seven or eight miles, and this thin

* Reprinted by permission from *Earth Sciences* by J. H. Bretz, published by John Wiley & Sons, Inc., 1940.

layer of about ten miles on the surface of the globe is his "environment" — hence the emphasis on geology, geography and soil science. These are useful sciences, and there is no objection in the world to studying them in the name of usefulness. But to study them in the name of the higher bunkum depends on a most naïve misconception of what is worth knowing about "man's environment." A criminal may be a criminal largely (but probably not entirely) because of his environment, but it was not the geology of the particular part of the earth's crust where he spent his youth that sent him to jail. Rather it was the fact that from childhood he spent his time with people who practiced safecracking and copslugging, and that he learned pickpocketing at his mother's knee. A savant may have been influenced in his choice of a way of life by the learned and bookish environment in his home. This is the important kind of environment to study, not the physics and chemistry of the earth's surface, the prevailing winds and the bacteria in the soil.

There is another kind of environment that is more worth studying than the "physical environment" of the science courses. I live in Hauppauge, Long Island, which constitutes the environment of my children. It is a country village, where country pursuits are carried on. If we were living twenty miles to

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the West, in Syosset, the environment would be quite different, for Syosset is a typical North Shore Long Island commuters' town. This is old-settled country: "Hauppauge" is an Indian word meaning "Sweet Water," and Smithtown, our shopping center, was founded by Richard Smith in 1659. Not far to the west is the birthplace of Walt Whitman. These historical facts are part of the environment, and I hope that my children will come to know them, and that they will also know facts relating to the present and the future, such as that the Long Island Rail Road was formerly owned by the Pennsylvania, and is constantly having difficulties, that a few miles to the southeast of Hauppauge is McArthur Airport, and that farther out on the Island atomic research is being conducted at Brookhaven. The physical environment — the type of soil and the climate — is also worth knowing, but it is a long, long way from being the whole story.

Professional educators play up the environment even more strongly than the regular scientists. The environment is regarded as a fixed, steady sort of *thing*, that is there, and the recipient of the education must be adjusted to it. "Education for Adjustment" they call it. Mr. Gerald Wendt, the publicist who wants the student and the citizen to absorb the scientific attitude to call their intelligence into play

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declares that "education . . . is primarily the adjustment of each individual to his environment, thereby fitting him for a successful place in it and for a happy life."* This is the swing of the pendulum away from schoolma'am discipline and the dullness of the tenth-rate village school where students were given complexes that unsuited them for any kind of environment for the rest of their lives. Of course an education is wrong that turns out social misfits, and certainly educators should take care to see that what they supply doesn't unsettle the students for life, either by overstrict discipline or by providing an environment so sheltered and delectable that the outside world seems, by comparison, unbearably harsh. All this is very fine, in a negative way, but as a positive aim it is monstrous and hideous. For it is *not* true that man must be adjusted to suit his environment. Man is remarkably capable of adjusting his environment to suit himself. Science is useful in finding out about the environment, and as a tool wherewith to change it, but it is no good having the ability to change the environment without some idea of what to change it into. Science cannot tell us in which direction to change the environment, or whether to change it at all. And if we meekly accepted the idea

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that man must be adjusted to his environment, where should we get our reformers from? Where our revolutionaries? How could we ever make things any better? Could we have had the American Revolution if George Washington had been successfully educated to be adjusted to his environment in America ruled as a colony? Why should we read of the Abbey of Thélème — *News From Nowhere* — Bellamy's *Looking Backward* and the other utopias if not to have a glorious vision, to be able to feel some dissatisfaction, rather than a smug satisfaction, with our environment? An educator should consider that he has failed in his job if he has not succeeded in instilling some trace of a divine dissatisfaction with our miserable social environment.

Though the system of Spread It All Thin, in the form of Survey Courses, or similar things called by some other name, is probably on the increase, at any rate the extremes of Pick and Choose are on the way out. Few colleges can now be found where the lush unpruned growth of the elective system still flourishes as in the old days. An "adviser" or "counselor" now moderates the students' choices, sometimes a "tutor" or even a "preceptor." This person, whatever his title, sees to it that a student whose interests are literary or artistic does not fulfill a credit requirement of, say, three courses in science by taking

Economic Entomology, Business Machine Operation and Home Cake Making. Instead, there may be some such arrangement as this, for example: — a student may have to take, as a freshman, either a biological science or a physical science, and in his sophomore year whichever he didn't take as a freshman, to see that he does not get too much of anything — and after that to hell with science. Sometimes there are elaborate systems of "blocks" or "areas of subjects" — or a "core curriculum"—or a "distribution requirement" and a "concentration requirement" — for educators are constantly trying to solve their problems by systems on paper. The "educationalists," who might be described as the more verbose educators, go even further with high-sounding phrases. For sheer blah blah blah and long-winded gobbledygook, educationalists are worse than scientists, and second only to politicians. They will "orient the curriculum" toward "intrinsic humanistic values." They will "plan a unified course of study," or "envision the fusion of broad fields" to avoid "excessive departmentalism." They "institute the critical exploration of problems." They "provide mechanism for review of personal adjustment situations." An "approach to value judgments" will be a "democratizing influence." A "comprehensive examination system" will be started, or an "independent study plan," or a "summer study

session" or a "winter field period." A "new method of vitalizing the form and content" will be "pedagogically significant," and will be followed, of course, by "enhanced significance" obtained by "re-vitalizing the form and content." A subject will "embody marked educational values," meaning that they think it is worth learning but they don't know why. And if they don't know why it is worth learning they will call it part of the Liberal Arts (always capitalized as if they were sacred), although what these arts are, and why they are called liberal, it is most difficult to find out. Many a rich man insists on his son having a "liberal" education although he would be horrified if there were any danger of his son turning into a liberal.

The effect of all this tergiversation upon the actual teaching in the scientific departments can be illustrated by a little story — an imaginary story, about an imaginary college, but typical of what happens. In a certain college there was a physics professor, chairman of his own small but respectable department. For a number of years he had been content to give a fine course in physics to the few students who chose to take this forbidding subject. Then the Survey bug hit the school. A committee was appointed to study Survey Courses, from the point of view of "the cultural values of the exact sciences."

The committee reported favorably to the Dean, who instructed the Chairman of the Department of Physics to "institute terminal courses as well as pre-professional courses." This meant that the physics majors continued to have the same course as before, the course that deservedly had the reputation of being a "toughy," for it involved plenty of the hard work that is necessary for really understanding something about physics, while the non-physicists were to be enticed into the classroom by a short Survey Course, called a "terminal course" because it would terminate their career in physics. It did just that, and all too quickly, for the Chairman of the Department, despising what he considered a watering down of true science, arranged to have the course given by his young junior instructor, a young man of burning ambition, great mathematical talent and no teaching ability, who loathed the course anyway, because as far as he could see teaching it did not contribute to his own professional advancement. The students stayed away in droves, to the great sadness of the physics professor.

At last, the Great Man decided that he would show that he too could be "cultural." He would descend and himself give the course for the "non-science" students. To attract the students, he gave it by the Gee Whiz method, or Ain't Science Wonder-

ful – "only think, for one cent's worth of electricity, thirteen trillions of electrons pass through the wire of this electric bulb!" The result was that the course was truly full of non-science, although nobody cared particularly about that.

But there was also an unexpected result that the professor cared about very greatly. He had made the non-science course so easy, while the pre-professional course was as stiff as before, that nobody took the "toughy" because they could get by with the simple "terminal" course. He wasn't getting any physics majors any more! This not only looked bad for the Department, it was bad for his own personal position, for he relied on routine experiments carried out by his graduate students for the scientific papers which he had to publish at least once a year to keep his place on the faculty.

The professor then determined to go back to the old system, and give just one course in physics, in which he would teach Physics, with no nonsense. But how could this be justified with the faculty and the Dean? He thought long and hard about this problem, but in the end it turned out to be easier than he imagined. The college was now in a swing of the pendulum away from Survey Courses, and the popular slogan at the moment was "Education as a Liberalizing Influence." When the professor boldly

announced to the faculty meeting "physics is a Liberal subject," he was surprised to find how easily he got away with it. The explanation was that every department head was thinking of saying the same thing of his own subject, and no one wished to challenge him, for fear of weakening his own position. Since no one had the faintest germ of an idea of which subjects are liberal and which are not, or even of what the word "liberal" means, the whole matter was settled with the greatest of good will and amity, and the college went on happily, just as it had done before.

Chapter III

SCIENCE AT ITS BEST — PHYSICS

THE various sciences can all be arranged in order, going from fairly good through mediocre to downright bad. Allowing the scientists to put their best foot forward, we may as well begin with the best of the sciences, which is physics.

Physics is, in a very general way, the study of all the material things in the world that are not alive. Looking at it this way, chemistry becomes a branch of physics — the distinction between conventional "chemistry" and conventional "physics" is largely one of convenience, and you can always call both of them together "physical science." Astronomy, geology, meteorology and some others are derivatives of the physical sciences, for they take the generalizations of physics and chemistry and apply them to certain particulars, the stars, the rocks and the weather. The next general division of the sciences is biology, which takes up things that *are* alive. Then

comes psychology, which does not confine itself to material things, but deals with thought — or attempts to do so — while last comes a hodgepodge of studies, dealing with men's relations with one another, that some enthusiasts (but by no means all scientists) have dignified by the name "social sciences."

Physics is the most highly developed of all the sciences, and it is also the oldest, for it got well under way as early as the seventeenth century. The other sciences followed later, and their proponents like to think that the reason they haven't got so far is that they haven't been at it so long. Actually there are other reasons, as we shall see later, but at least they are right in paying deference and respect to physics, which is unquestionably science at its best.

The first thing to realize about physics, a thing which very few physics teachers make really clear, is its extraordinary indirectness. It appears to begin with very straightforward questions, but there are catches in it right from the start. Every high-school student is told that according to Aristotle the heavier of two weights would fall faster, but that Galileo, by dropping two different weights from the leaning tower of Pisa, "proved" that Aristotle was wrong, for the weights were found to fall in exactly the same time. And yet Aristotle was right. The heavier body does fall faster, because of air resistance, which slows

up the lighter body more than the heavier. Only a very little faster, it is true, and the difference may not be detectable, but since scientists claim that they use words with such great precision, it is fair to hold them to it. If you press a physicist on this point, he will readily admit that what he means is that the two bodies would fall equally fast *in a vacuum.* If you press him further, he will very reluctantly admit that nobody has ever made a vacuum, and the closest to a vacuum anybody has ever made still contains millions of gas molecules per cubic inch. And so it turns out that the physicist's statement, that the two bodies fall at the same rate, refers to an entirely hypothetical, unreal state of affairs, whereas what Aristotle said refers to the actual world that we live in. This is characteristic of physics, all the way through. Yet it is because of this, and not in spite of it, that physics is the best of the sciences. For physics is not about the real world, it is about "abstractions" from the real world, and this is what makes it so scientific. It has all the proper attributes — the importance of exact measurement, the reduction of everything to mathematics, the carefully defined and precisely used terms, the pitilessly rigid trains of logical thought — that are commonly ascribed to everything that goes by the name of science. Other so-called sciences are scientific in so far as they

approach the dignity of physics, and it would be only a slight exaggeration to say that physics *is* science, physics and nothing else. For physics shows, more often, more clearly and more successfully than any other branch of knowledge, the one operation that is truly scientific, and that is the framing of hypotheses to "explain," or render intelligible, the results of observation or experiment. The hypotheses are always in terms of "abstractions," which are, strictly speaking, unrealities, such as the perfect vacuum in which all bodies are supposed to fall equally quickly. Theoretical physics runs along merrily with these unreal abstractions, but its conclusions are checked, at every possible point, by experiments. The experiments have to agree with the theory as closely as possible, but since no measurements can be made without some slight inaccuracy, the agreement is never absolutely complete. "Nearly equal" is the same as "equal" to a physicist.

The best things in physics are fully as admirable as the scientists claim them to be, perhaps even more, in view of the scientists' habit of praising science for the wrong reasons. Humanists, the professional dishers-out of Shakespeare and other geniuses, claim that their specialty brings one in contact with "the finest that the human mind has produced." So does physics, for it would be hard to find, in the whole

history of human thought, a grander conception than Newton's laws of motion and the theory of gravitation. This is an amazingly bold assumption, or rather pair of assumptions, that are now so much a part of all our thinking that it is difficult to realize their astonishing and striking character. It is first assumed that a moving body does not, as everyone would at first suppose, require a force to keep pushing it along, but on the contrary would go on moving for ever if it were not for some force *stopping* it. The second assumption is, on the face of it, even more preposterous; it is that any two objects, anywhere, are all the time "attracting" one another. Not the faintest suggestion is put forward as to how this mysterious "attraction" takes place, although it works at a distance, even a very great distance, with no sign of anything to account for it in the space between the two objects. Making these two wild and improbable-sounding assumptions, and a few sub-assumptions concerning the magnitude of the attractive force and of the effects of "force" on objects, the most amazing results come out. All the phenomena of astronomy, which had baffled the acutest minds since the dawn of history, the movement of the heavens, of the sun and the moon, the very complex movements of the planets, suddenly tumble together and become intelligible in terms of the one staggering assumption,

this mysterious "attractive force." And not only the movements of the heavenly bodies, far more than that, the movements of earthly bodies too are seen to be subject to the same mathematically definable law, instead of being, as they were for all previous philosophers, mere unpredictable happen-so's. This is science on a grand scale. This is science worth knowing about.

Very few people who have been exposed to physics know anything about gravitation in this sort of way. For instead of being explained as a wild, thrilling and gloriously successful intellectual adventure, it is taught just as one of the first things to be got through in "Introductory Physics I." The students are "given" the law, and since it comes fairly early in the course, before the work begins to get really tough, they are allowed to read several easy textbook pages which are devoted to praising Newton in extravagant terms, without, however, making clear why he is deserving of praise, or giving any idea of how he discovered his famous law. Rapidly the course goes on to other things, for there is so much ground to be covered that it is difficult to take time out to explain why one should be bothering about physics at all.

Physics is full of magnificent theories — the true stuff of science. One of the finest is the wave theory of light; fine because in spite of being exceedingly

indirect, it is amazingly successful in explaining what light actually does, in a big way and also in minute detail, with elaborate mathematical calculations. Light is supposed to consist of vibrations, or wave motion, in something or other, somewhat like waves on the surface of water, but moving very much more rapidly. The theory is particularly worth studying because it tells one about vibrations, what they will do and what they will not do. Now, every fortuneteller and dabbler in the psychic talks a blue streak about "vibrations," usually without having the faintest idea of what he is talking about. A little knowledge of the physics of light is therefore most useful in recognizing a crackpot for what he is (there are so many vibration phonies, they talk such utter nonsense, and they take in so many people). There ought to be special courses in "Wave Theory for People Who Want to Make Sense," or "Vibrations for Occultists." This would drive home an excellent reason for learning something about physics. But physics teachers don't seem to see it this way; to them, the reason for studying physics is to know something about physics — a narrow viewpoint.

The theory of light also gives a wonderful example of another of the great ideas of science, the "crucial experiment," or, as it used to be expressed with a fine dignity, in Latin, the *experimentum crucis*. A scien-

tist has a theory, let us say, which accounts for something or other – the properties of light, the behavior of falling drops of water, or anything else. Another scientist has another theory, quite different, which will *also* account for exactly the same things. Which is right, or which is wrong? To settle the point, they work out all the possible consequences of the two theories, until they find a place where one theory says one thing, and the other something quite different. Then it is only necessary to do the appropriate experiment (and it will only do one thing, not the other), and this will allegedly "prove" one theory and "disprove" the other.

This is exactly what happened in the case of the theories of light. An older theory than the wave theory, attributed to the great Newton himself, was that light is not waves, but little "corpuscles," or tiny bits of something, which are shot out in straight lines by any bright object: when these corpuscles hit the eye, we "see." This theory also can explain many of the properties of light, although it is quite different from the wave theory. From about the beginning of the nineteenth century on, the wave theory became quite generally adopted, because it could explain very slickly and easily a number of things that had then been discovered, which would require considerable twisting and straining of the corpuscular theory.

Later in the nineteenth century a very clear crucial experiment was done. It depended on measuring the velocity of light, and it worked like this: on the wave theory it was necessary to assume that light traveled more slowly in water than in air, but on the corpuscular theory light would be expected to travel *quicker* in water than in air. Measuring the velocity of light is not easy, but as soon as apparatus was available for doing it the crucial experiment was carried out, and it showed that light traveled slower in water than in air, and just that amount slower that the wave theory demanded. Scientists therefore concluded that the corpuscular theory was wrong, and that the wave theory was right, and this beautiful crucial experiment was regarded as one of the high spots of science.

But alas, although the corpuscular theory appeared to be completely dead, it did not stay dead. It became absolutely necessary to revive it. It was discovered that light has strange ways of behaving that can only be accounted for by assuming that it comes in little separate packets of something, which are now called "quanta," to get away from Newton's word "corpuscles." But then, there are also the phenomena that the wave theory is so successful in explaining, and, of course, the crucial fact that light travels slower in water than in air, which it was supposed

the corpuscular theory couldn't possibly explain. I became necessary to devise a theory which has thing both ways, combining the good features of both o the earlier theories. "We teach quantum theor on Mondays, Wednesdays and Fridays, and wav theory on Tuesdays, Thursdays and Saturdays," sai Sir William Bragg, and the great crucial experiment which was supposed to have decided things onc and for all, is played down. It shouldn't be playe down, it ought to be played up, for one learns some thing from it about what physics actually is like Physics is *not* a body of indisputable and immutabl Truth; it is a body of well-supported probabl opinion only, and its ideas may be exploded at an time. This ought to be more generally known, an should be widely publicized. Perhaps it would b hardly in human nature to expect physicists to d this for themselves, but somebody else ought to do i for them. Physicists, being in no way different fro the rest of the population, have short memories fo what is inconvenient; Millikan, American Nobe prize winner in physics, writing a popular book abou science in 1936, actually said, "In science, trut once discovered always remains truth." *

Away back in the old days, when the wave theor

* *Science and the New Civilization,* by Millikan (New York: Charl Scribner's Sons). Reprinted by permission.

that light consisted of vibrations having been indisputably "proved," was regarded as Truth and questioned by no one, scientists "postulated" what they called the ether, or "the luminiferous Aether," which was to do the vibrating. It was a sort of — well, it's hard to say what it was like, because it was not like any *substance* that we know at all; but whatever it was, it was everywhere, permeating all space, whether that space happened to be occupied by matter or not. It had to have the most amazing properties — if they could be called properties: the ratio of its elasticity to its density had to be vastly higher than for any known substance — 9 followed by 20 zeros — and it had to offer no resistance whatsoever to solid bodies moving through it, if indeed they could be said to move through it, for they did not displace the ether, but on the contrary the ether permeated right through them. But hard as it was to believe in, and it was quite strictly impossible to imagine it, one had only to suppose (or "postulate") that it was there, and all the then-known phenomena of light became completely and utterly "explained." And this is what science is always aiming for, the making of some postulate that will explain the phenomena. The nineteenth-century British physicist, Lord Kelvin, was so satisfied with this triumph of science that he declared himself to be as certain of

the existence of the ether as a man can be of anything.

Modern physicists pay no attention whatever to the ether. They have simply given up bothering about such a thing. They began to entertain doubts about it when it appeared that they never could find it, however hard they looked. If the ether fills all space, then the earth, in turning on its axis, and in going around the sun, ought to be moving through the ether. It should have been possible to get experimental evidence of this movement of the earth through the ether. But it wasn't, no trace of such motion could be found. But just possibly the earth, whichever way it moved, always carried the ether around with it? There were objections to this idea, too. Whatever the physicists did, they could not find the ether: it never revealed itself as the result of any experiment. So the scientists reconsidered their idea, in terms such as these: "Why did we ever suppose there was such a thing as the ether, anyway? Because we found that light is vibrations, and there must be something to vibrate. But must there? That is only a grammatical necessity, to supply a subject for the verb 'vibrate.' We are not bound by grammatical necessities — throw it out!" So they threw it out, and they didn't even take the trouble to consult a spiritualist to find out what Lord Kelvin thought about it.

When they come to the distinctively modern theo-

es — and they come to them as soon as possible, for
ıey love them — the physicists candidly admit a cer-
ın Alice in Wonderland quality about their science.
hey are even proud of it. They loudly trumpet the
ındamental change in all our philosophy which,
ıey say, has been made necessary by Relativity
heory and by Quantum Theory. The theory of rela-
vity certainly does queer things. According to it, the
me order of two events can be scrambled for two
ɔservers. One observer thinks that A precedes B,
ıt another (who is supposed to be moving past the
st observer with an incredibly high velocity) finds
at B precedes A. Marvelous, is it not? And utterly
structive of all our preconceived notions about
ne? But the science propagandists, who delight in
wling over the unfortunate "layman" with this sort
seeming paradox, don't always point out that the
ents A and B have to be exceedingly far away in
ace — billions of miles — and very close in time.
ıey are so far away that after the first observer has
en A he would be unable to do anything to stop B
ɔm happening, because he couldn't get any sort of
nal to it in time to stop it, and similarly the second
server, after he has seen B, would not be able to do
thing to stop A from happening. Our ordinary
as of cause and effect are not altered at all. A can-
be the cause of B, nor B of A, for either observer,

nor for anybody else. But if two events, C and D, are close enough in space and time so that C might have been the cause of D (that is, if a signal from C could get through in time to stop D, or to cause it), then C could have been the cause of D for *all* observers, no matter how fast they may be buzzing through space in all directions. Our ordinary ideas of casuality are not upset in the least. Few scientists, expatiating on the marvels of modern relativity, take the trouble to make this really clear. They delight in paradoxes, even artificial ones.

Scientists have a horror of the Absolute, but as a word, rather than as a concept, for few of them have any clear idea of what it means. Relativity is accepted with great delight by modern scientists, for Einstein is regarded as having done away with Absolutes, replacing Absolute Time and Absolute Space by a four-dimensional space-time continuum which is pleasingly Relative. The momentum of this carries over into other fields, and everything possible is now considered to be relative; morals are relative, meanings of words are relative, even truth is relative, and the more things a man can describe as Relative, the greater his prestige as a Modern Thinker. And yet Einstein did not destroy the Absolute. There is always an Absolute in science. In the nineteenth century it was the ether, but when the ether fell to pieces

and disintegrated, there was no Absolute left at all — a condition intolerable to scientists, although they don't know it. Einstein made space and time relative, but in order to do this he had to take something else, which was the velocity of light, and make it absolute. The velocity of light occupies an extraordinary place in modern physics. It is *lèse-majesté* to make any criticism of the velocity of light. It is a sacred cow within a sacred cow, and it is just about the Absolutest Absolute in the history of human thought. There is a textbook on physics which openly says, "Relativity is now accepted as a faith."* This statement, although utterly astounding in what purports to be a science, is unfortunately only too true.

In the grand old nineteenth-century days, physicists were convinced that everything goes according to rule. The Laws of Nature had to be discovered, and then it would be possible to work everything out. The stars in their courses all obeyed the Law of Gravitation. Light was vibrations, and these were understood pretty thoroughly. Electricity was rather more troublesome, but many of its laws had been found, and the rest would eventually be discovered, given enough time. And when all the Laws of Nature were in, it would be possible to predict *everything*, pro-

* Houston: *Treatise on Light* (New York: Longmans, Green & Co., Inc.), Seventh Edition, 1947.

vided we had the necessary data. If we could know the position, and the velocity (and perhaps a few other things) of every atom of matter in the entire universe, then the Laws of Nature could be used to predict the whole future course of the entire system. This belief is called determinism, and up until the end of the nineteenth century it seemed quite plausible. But the quantum theory, developed about the turn of the century, shook it severely, and ever since then physics has lost much of its brazen self-confidence — to its own very great improvement.

Quantum theory is tricky stuff. To understand it fully requires a lot of mathematics, and it is far from easy to explain its important conclusions in words without making oversimplifications. This is what R. C. Tolman, Professor of Physical Chemistry and Mathematical Physics at California Institute of Technology, says about it: "In agreement with the Heisenberg uncertainty principle, we now see that a complete knowledge of the state of a physical system at any given instant is not sufficient to permit an exact prediction of that system's future behavior. The best that we can do is to make statistical calculations concerning the future behavior that can be expected on the average. As a consequence, we now have to regard the true connection between physical cause and effect as a statistical one and give up the idea that

the behavior of the physical world is strictly determined."*

These dry words mean that physicists have now found that determinism does not work when applied to extremely small things, such as electrons and atoms, when considered individually. They cannot tell what an electron is going to do, nor when it is going to do it. They can tell about a great many electrons, in an average way. Of a million electrons they can say "600,000 will perform such and such a manoeuvre within one second, and 400,000 will not," and although in the event it may be 600,001 electrons that do it, or even 600, 002, what are one or two electrons among so many? For ordinary practical purposes an uncertainty about one or two electrons makes no difference at all, for we normally deal in electrons not in measly millions, but by the quintillion, but at any rate the old-fashioned determinism is gone. It is now believed that it would never be possible to predict the future *completely* from any amount of knowledge of the present, however extensive, and this is a great change from the nineteenth-century idea. But although all physicists roar and bellow for a fundamental change in our basic philosophy on account of relativity, many of them

* "A Survey of the Sciences," by Richard C. Tolman, *Science* magazine, August 15, 1947. Reprinted by permission.

are reluctant to make much change on account of "the Heisenberg principle of uncertainty." Sir Arthur Eddington, and some others, came out and said that the uncertainty principle allows of free will. They carefully refrained from saying that it "proves" free will—it doesn't, it only "allows" of free will—but they have been jumped upon by other physicists for saying even this much. The orthodox scientific attitude is that only popularizers and sensation seekers, who misunderstand the high truths of modern physics, have the idea that Heisenberg's discovery has anything to do with the ancient problem of Free Will. Professor Tolman puts it this way: "The opinion of one good physicist that the uncertainty principle brings free will and moral responsibility back into the world can hardly be regarded as sensible. As far as I know, moral responsibility has never left the world."*

There is a reason for this curious reluctance of physicists to draw any important conclusions from their own discovery of "uncertainty." It is that they had never previously drawn the proper conclusion from the "certainty" principle. In the old days (a hundred years ago and more), when scientists were clearer, harder thinkers, and better philosophers

* "A Survey of the Sciences," by Richard C. Tolman, *Science*, August 15, 1947. Reprinted by permission.

than they are now, it was believed that *inanimate* nature followed a completely deterministic pattern, but it was by no means certain whether the matter in living creatures followed this pattern or not. There might have been a "Life Force" or "*élan vital*" (or call it by any other name you wish) which made live matter entirely different from dead matter. In much more recent times scientists began to think, without any really compelling reasons, that this was not so, and they assumed that determinism went right through the universe, dead matter, live matter and all. But they did not draw the full conclusion from this. If what *you* do, in the next ten seconds, is entirely and completely determined by the present and past position of the atoms in your body, then there is no choice, no free will, and no moral responsibility. Modern physicists hang out no flags of welcome for the return of moral responsibility, simply because they do not realize that it had ever gone away.

But leaving aside, for the moment, these higher philosophical realms, we may look at the chemists, who are first cousins, if not brothers, to the physicists. Chemists are, on the whole, like physicists, only "less so." They don't make quite the same wonderful mistakes, and much of what they do is an art, related

to cooking, instead of a true science. They have their moments, and their sources of legitimate pride. They don't split atoms, as the physicists do, they join them together, and a very praiseworthy activity this is. "Better things for better living — through chemistry," as the letterhead of one of our greatest chemical firms says.

In their propaganda, their explicit reasons why one should bother about their science, chemists use much the same persuasions as the other scientists, with the addition of a certain hysterical note, which seems to be characteristic of the test tube artists. "After centuries of toil, a long uncertain dawn burst into the full glow of day when finally, in the middle of the last century, the chemist learned how to put together some of the structural units of matter and convert them into new substances — a process called synthesis. With the advent of synthetic chemistry, the modern world was born."* These are the exoteric reasons; the esoteric reasons are these: ". . . Not so much to impart a detailed knowledge of a wide range of facts as to create a scientific spirit; a spirit of toleration and of co-operation, of intellectual adventure and intellectual honesty, which seeks ever to enlarge our knowledge of the external world and to found

* *Elementary General Chemistry,* by Hogg and Bickel (New York: D. Van Nostrand Company, Inc.) © 1941. Reprinted by permission.

that knowledge, not on tradition or authority, but on a basis of ascertained fact."* The same old story. If only it were true!

Chemists have a habit of beginning in the middle of things, and then making little excursions backwards. The class in Chemistry I, meeting together, 300 strong, for the first time, may hear the Great Man announce in a booming voice, "Now a hydrogen atom is made up of one electron and one proton." Only later do they find out what is meant by "atom," "electron" and "proton," and only much later still, if at all, do they find out any of the facts that justify scientists in believing in these things. Later on the class may embark on a project of building, out of wood and wire, an exceedingly complex model of what an atom is supposed to be like. Needless to say only a very few students who go on to be specialists will find out, after years of study, the experimental evidence on which all the complexities are based, and by the time they have got there the whole theory of atomic structure may be quite different. Completely gone is any pretense of inculcating the virtue of reserving judgment until all the facts are in. But there are other virtues. A carefully simplified approach to atomic structure is believed by one chemist

* Finlay: *The Spirit of Chemistry* (New York: Longmans, Green & Co., Inc.). Reprinted by permission.

to be "marvellously inspiring evidence of a penetrating — almost religious — cosmic unity."*

To prevent the intricacies of atomic structure from becoming altogether too exciting, fragments of history are brought in from time to time. This is done because it is a very common belief, around colleges and universities, that a little history of science contributes to "culture." Since nobody has any clear idea of what "culture" is, it is difficult for the liberal arts men to contradict the scientists, who score in this way a shrewd blow in the continual battle for increased appropriations.

"Culture" and "human interest" are dragged in by the scruff of the neck in the form of little potted biographies of famous chemists of the past. John Dalton, the Father of the Atomic Theory, was born in 1766, in England. He was a schoolmaster in Manchester. "The atomic theory, on which his fame mainly rests, was made public in 1807. A man of quiet, retiring and modest character, Dalton found his greatest satisfaction in the pursuit of scientific truth. With his achievements and name recognized and honoured both at home and abroad, Dalton died in Manchester in 1844."† A contemporary of his,

* *Journal of Chemical Education* (La Jolla, Calif.), January 1947. Reprinted by permission.

† Finlay: *The Spirit of Chemistry* (New York: Longmans, Green & Co., Inc.).

Avogadro, and a later chemist, Cannizaro, both of whom contributed importantly to the same subject, do not rate biographies, possibly because they were Italians. Lavoisier, although a Frenchman, always has his biography, because of the dramatic end to his life — he was guillotined in the French Revolution, with the scornful words, "The Republic has no need of savants." The really interesting things about the biographees don't get said. Manchester has the reputation of being a very dull city, and the standard biography of Dalton only goes to confirm this, but in the early nineteenth century it was far from dull. It was right in the middle of the Industrial Revolution, and in the throes of converting itself from a small country town to a very large manufacturing city. Dalton was not just an accident, the one outstanding figure thrown up almost by mistake by an undistinguished town, for there were plenty of interesting things going on in Manchester — the Manchester school of economists, Free Trade, *The Manchester Guardian*, "What Manchester thinks today, London will think tomorrow." The conventional account of Dalton just sticks to Dalton, without giving anything extra that would make the biographical facts interesting and worth knowing by tying them in with the rest of history.

At any rate the chemists remember what they say

about the Scientific Method — for about half the way. They seldom fail to give a tedious account of one of Lavoisier's important experiments, to show how free from dogmatic prejudice he was, how he learned the truth from Nature, and all the rest of the standard claptrap. Of Dalton's atomic theory, they carefully weigh all the evidence, and show how the hypothesis accounts for the facts. They keep this up as far as the late nineteenth century, and then they relapse into the style that comes far more easily to them, that of simply *telling* what the theories are, and letting the facts go hang. One would think that the famous Scientific Method died with Lavoisier on the guillotine, or was buried with Dalton in Manchester.

If the idols of scientists were piled on top of one another in the manner of a totem pole, the topmost one would be a grinning fetish called Measurement. Both chemists and physicists fall down and worship before Measurement. They point out quite truly that it has been only by painstaking measurement that the physical sciences have been able to advance at all: that almost anyone can devise a vague, qualitative, imprecise explanation of anything in physics, but it will be apt to collapse when subjected to a quantitative test. On the other hand, if a theory can account for the things it is supposed to explain, not only in a rough, general way, but in every exact detail, then we

can have much more confidence in supposing this theory to be "true," or at any rate highly plausible. For example, the wave theory of light required that the velocity of light should be less in water than in air, but not just vaguely "less"; it had to be just 25 per cent less and not any other figure. The measurements confirmed this, and in many other ways this famous theory showed an accurate agreement with measurements. The physical scientist therefore measures things to see if they give a precise agreement with his theory; or if he does not at the moment have a theory, then he makes the measurements anyway, in the hope that a theory will turn up later. Measuring becomes second nature to a physical scientist; he does it from force of habit. This is the explanation of the extraordinary degree of dullness that pervades the laboratory periods of physics courses, a dullness so acute that for many people it is the bitterest experience of their education. The physicist sees everything in terms of measurements, and he feels he has to indoctrinate his pupils with this idea. Show a magnet to a physicist, and to a man in the street, and what happens? The physicist wants to measure its "magnetic moment," the other fellow wants to use it to pick up phonograph needles. If there is a weight, the physicist must weigh it; if it is "falling freely under gravity," he must measure its velocity and accelera-

tion; if there is electricity in the room, he must know the volts and the cycles, and when the current is turned on he must measure the amperes and count the electrons. If there is light in the room, he must measure it in lumens, and if a pneumatic drill opens up in the street, the physicist, instead of putting his fingers in his ears, will measure the sound in decibels.

Since measurement is so frightfully important, quite naturally physicists have very decided ideas about it. It is above all things necessary that different physicists, working perhaps in different parts of the world, should be able to get the same answer when they measure the same thing — such as the velocity of light,or the mass of the earth, or the intensity of the sun's radiation. To be able to do this they have developed what they call "operational definitions," which are clear descriptions, not of the thing that is to be measured, but of the precise means to be adopted to measure it. Instead of explaining what a thing is, they say how many times bigger it is than some other thing — for that is all that measurement really is. Thus, for a physicist, the means of measuring a thing *is* the thing: light *is* just so many lumens, noise so many decibels, and a magnet so many units of magnetic moment. And so their way of explaining any of the more abstruse concepts of physics is to have the students measure them at once, although it

can easily come about that the victim of a physics course can go through the operations perfectly, produce exactly the right measurement, and still not have any idea of what he has measured.

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of *science*." Thus did Lord Kelvin lay down the law. And though quite wrong, this time he has the support of official modern Science. It is *not* true that when you can measure what you are speaking about, you know something about it. The fact that you can measure something doesn't even prove that that something exists. This may seem strange, but it is true, and there are plenty of examples to prove it in physics. Take the ether, for example: didn't they measure the ratio of its elasticity to its density? *That* didn't make the ether true. To take another example, in astronomy, and going back some considerable time: the ancient astronomer Ptolemy and the Renaissance astronomer Copernicus (and all astronomers in between) explained the movements of the planets by what they called "epicycles," which were arrived at

by a strict application of the modern scientific method. These epicycles were measured, and their size was recorded with very great precision. Yet they have absolutely disappeared, and for three hundred years and more, no astronomer has used an epicycle or anything like one.

If you look at, say, the edge of a table, you know that it is there, and you can measure it by getting a ruler and laying it off so many times along the edge of the table. But you do not know that it is there *because* you are able to measure it; it is the other way round, you are able to measure it because it is really there. You measured it by taking your standard of comparison, the ruler, and placing it alongside the thing to be measured, the table. This is genuine measurement, and only things that really exist can be measured in this way. Unfortunately, there are many measurements in physics that are not made in this genuine way at all. When physicists say that the diameter of a hydrogen atom is two ten-millionths of a centimeter, do they mean that they took a ruler marked out in ten-millionths of a centimeter, brought it up alongside a hydrogen atom, and compared the two? Not a bit. They didn't do anything of the kind. They simply made one of their hypotheses; they reasoned that *if* the diameter of the atom were that number of ten-millionths, then the results of a certain

experiment would be thus and so, exactly the way it was actually found to be. The same indirect kind of "measurement" was made in the case of the epicycles, or the ether; it was reasoned that if the ratio of the elasticity to the density of the ether were that enormous number, then the directly measurable properties of light would be just what they are found to be. A great many of the measurements of physics are of this indirect kind, which gives no proof at all of the existence of the thing that is alleged to be measured. It is not true that we know about atoms, *because* atoms have been weighed, measured and counted, although physicists often make this implication. It is not true that we know there are atoms, because certain kinds of work in physics are described as "atom-smashing"; maybe the physicists are entirely deluded in thinking that the results they get from their cyclotrons are anything to do with atoms. It is not true that there must be atoms, because there is an atomic bomb: the existence of the *bomb* is indisputable, but is it atomic? It is within the bounds of possibility that the physicists of a hundred years from now will look back with amusement to the days "when they thought that that crude bomb of theirs had something to do with 'atoms,' as they used to say. Of course, we know better, now."

Do we have any proof, then, that there are such

things as atoms? The answer is that physics can never *prove* things in the way things are proved in mathematics, by eliminating *all* of the alternative possibilities. It is not possible to say what the alternative possibilities are. At present no one can think of any alternative to the atomic theory, but that does not prove that tomorrow someone may not think of some utterly astonishing new theory that does without atoms. And so the existence of atoms is not proved, but only rendered highly probable. But it is rendered *very* highly probable. The lines of evidence that lead to the belief in atoms are many, and in spite of being very different they all lead in the same direction. *One* measurement of an atom doesn't prove it at all; neither do many measurements, if they are really the same measurement, for nothing in particular is added if the same experiment is repeated again and again. But atoms can be measured by various *kinds* of experiments, and the fact that they all lead to an atom of the same size gives one a good deal of confidence that the thing described as an "atom" really exists. The phrase "a good deal of confidence" is an understatement: the evidence for atoms is so strong that it is in the highest degree improbable (although not *quite* impossible) that anyone will ever be able to account for all the facts that are now known without using atoms of some kind. And that

is near enough to a proof for all practical purposes, and it certainly justifies the physicists in going ahead, as they do, with an unshakeable faith in their atoms. And yet even at that, they overdo things. A physicist once said, "One of the things which distinguishes ours from all earlier generations is this, that WE HAVE SEEN OUR ATOMS."* He didn't really mean it. He knew that there is very good reason for thinking that we shall *never* be able to see atoms. The idea at the back of his mind, being translated, is "the path of a single high-speed atom can be observed and photographed just as the trail of a shooting star can be observed." He meant only that we can see the *trail* of an atom. Now just suppose that a hunter were to announce, "I saw a tiger on Long Island yesterday"; if, on close questioning, he were to back down to "what I mean is, I saw the trail of a tiger," would he be believed in the clubhouse?

Though it is easy to blame physicists for some excesses and exaggerations in talking about their own subject, it is also easy to praise them. The enormous importance of their science has recently come to be recognized. In the last war all the notable advances — radar, proximity fuses, blind flying, the great A-bomb itself — were due to physics. In the

* K. K. Darrow: *The Renaissance of Physics* (New York: The Macmillan Company) © 1936.

previous war it was chemists: they developed horrible explosives, and even more unspeakable poison gases. Scare pictures, in the time between the wars, showed a ghoulish chemist glaring over a test tube, while the rest of the population had to go about in gas masks. These possibilities for evil made the chemist a feared and respected figure, and with the social power that he gained from this prestige he went ahead and developed rayon, nylon, improved tires, batteries and gasoline, drugs, cosmetics, plastics, atabrine and DDT. Those twenty-odd years were the great period of applied chemistry. The phrase "physics professor" in those days connoted a shy and almost laughable figure, who would slink furtively about the campus. It is quite different now. Physics professors hold themselves up straight, and are quite capable of going up to Prexy, slapping him on the back, and saying, "How about that million dollars for the nucleonics lab?"

In their propaganda, the reasons they give why other people should pay attention to what they say, physicists claim rather more than is fully justified. But then for that matter, so does everybody else. And at least some of the physicists' claims really are justified. It is *true* that physics gives a wonderful training in precise, logical thinking — about physics. It really

does depend upon accurate reproducible experiments, and upon framing hypotheses with the greatest possible freedom from dogmatic prejudice. And if these were the really important things in life, physics would be an essential study for everybody. Physics is a splendid subject, as far as it goes, but it doesn't go far enough. It doesn't go any further than just physics — the physical world. Physicists are not always fully aware of the limitations of their method of going about things, but they could well counter by asking, Who is? The lawyer sees everything in terms of statutes and cases, the soldier in terms of "national defense and preparedness," the journalist in terms of headlines and scoops, the educationalist in terms of classrooms and semester hours, the National Association of Manufacturers in terms of manufacturing, and everybody else in terms of what he or she may be doing. If we want to learn about the limitations of physics, a physicist is not the person to go to. But, that there are limitations to physics — consider the picture that physics puts forward; the world is seen as made up of electrons and protons (Oh yes, and positrons and neutrons and deuterons and mesons and a few other "ons") which are continually interacting on one another, and sometimes jumping from place to place in an unpredictable

manner. But is the universe to be thought of in terms of electrons and protons? Or is it to be thought of in terms of Good and Evil? Merely to ask the question is to realize at least one very important limitation of physics.

Chapter IV

BIOLOGY, OR KNOW THYSELF

"Every person living today is descended from an unbroken 11-million year old line of ancestors who had mated at least once in their life. It is fairly certain that most of these ancients hardly knew why they mated, nor sensed the consequences. They were simply obeying a behavior pattern, (like mother love) dictated by certain amazing chemicals in the blood stream."*

Maybe they didn't "sense" the consequences, but they knew why they mated — they enjoyed mating.

Evidently in biology there is the same tendency to utter pompous nonsense that characterizes scientists of all kinds. But does biology have the virtues of science? That is more questionable.

If one of the reasons for bothering about science is its logical thinking, then biology is hardly on the map. If you take a course in biology, or read any of the textbooks, you will find extremely little that can

* *Journal of Chemical Education* (La Jolla, Calif.), January 1947. Reprinted by permission.

be called scientific in any scientific sense. For there is practically nothing there but descriptive facts, and facts alone do not make a science. Here is a representative sample of what is handed out — not a complete summary, for that would be tedious, but enough to give the idea. The fundamental stuff of all living matter is called protoplasm — all living matter is organized into cells — the lowest animals have only one cell — plants synthesize carbohydrates by means of chlorophyll — the structure of a dogfish is — and here will follow a long mass of descriptive details about a dogfish — the body of any higher animal, including man, shows many resemblances to that of a cat — and you are supposed to cut up a cat — the nervous system is this way in a mammal, that way in a bird, the other way in a reptile and some other way in a fish — similarly for the skeleton and other systems — reproduction is by special glands called gonads — anabolism and catobolism — stimulus and response — thallophytes bryophytes pteridophytes spermatophytes—parasites and predators—the plant succession in ponds — the social insects, and so on and on and on to the end of the course, and where in the name of heaven is anything scientific in all that? You can get full marks in the course, and read to the end of the book, without encountering *any* train of reasoning.

Science that is genuinely science begins, of course, with describing facts, but it does much more than that. It explains them, by making hypotheses or theories, which must agree with experiment, preferably exactly and quantitatively. The atoms of physics explain a great many things. So do the "waves" or "corpuscles" (whichever they are) that physicists have thought up to explain light. It stretches the mental muscles very considerably to follow up the consequences of these hypotheses, and the effort of doing this certainly justifies some, but not all, of the scientists' extravagant claims. But you can get through a course in biology with nothing but a good memory — and there are plenty of other ways to train memory.

A typical example of what passes as a theory in biology is the "cell theory." This usually rates a little potted history — "culture" again — and goes along these lines: In 1838 a German botanist named Schleiden had noticed that in a large number of plants the living tissues were always divided into cells. A year later a zoologist named Schwann made the same observation for animal tissue; the two scientists got together, and each was struck with the similarity of the discoveries that had been made in the two different fields. The theory that resulted from this is that the living tissue of *all* live organisms is divided

into cells. "Today we know the cellular theory of living organisms to be a fact: it is no longer a theory." So what? Then the living tissue of all live organisms is divided into cells. This is not a theory, as the physical scientist understands theories, but a simple statement of observed fact.

And yet, the biologist will candidly admit that there are some live organisms that don't have cells! They are degraded things called slime molds. The biologists get around that by a typical scientists' quibble: all cells have nuclei (another statement of observed fact); the slime molds have a lot of nuclei, but instead of being separated from one another by neat cell walls they are scattered around like plums in a pudding; so it must be that these low organisms have degraded cells, the walls separating cell from cell having vanished away. So that quite strictly speaking, and scientists always insist that they do speak strictly, the theory (or rather the observation) isn't true.

To pep it up a little, and to disguise the quibble, an official pronouncement may be made in some form of words that *sounds* as if it had a meaning, such as "The cell is the fundamental unit of all life." Anyone can learn and remember this statement, and if ever you undergo a quiz in biology, that is *the answer*, it is what you are supposed to write down. And yet

what does it mean? If the cell is a unit, in the sense that bigger things are made up of it, this only means, all over again, that living organisms are made up of cells (except those that aren't). But if the cell is a *fundamental* unit, what does "fundamental" mean? Think about this as much as you like, or as much as you can, but if you are facing a quiz, do not worry about it, for you will never be asked what, if anything, is conveyed by the word "fundamental."

Another of the gloriously vague ideas of biology is "protoplasm." It is the "fundamental" living substance, the content of the cell. It, alone, is alive, and when it is dead it immediately starts to decompose, and is no longer protoplasm. There is no such thing as dead protoplasm. The chemical composition of protoplasm is excessively complicated, and is not the same in any two kinds of animals or plants, even closely related ones, and is probably not quite the same even in two individuals of the same species, but the biologists call it all "protoplasm," wherever it comes from. "Protoplasm" is a convenient word, so convenient that biologists are convinced that all that is called protoplasm is, in some mysterious way, the same, although it is different. In just what way it is all the same they are never able to explain, and so they take refuge in a high-sounding phrase, "all protoplasm is *essentially* alike." And nobody asks

them what, under the sun, they really mean by this. Their meaning, in so far as they have one, is strictly mystical, or as they themselves would express it, "metaphysical."

The truth is that biologists don't think, at least not in the narrow sense of making formal conclusions, definitely arrived at from definite premises. Their mental processes go by analogy. Analogy is a wonderful, useful and most important form of thinking, and biology is saturated with it. Nothing is worse than a horrible mass of undigested facts, and facts are indigestible unless there is some rhyme or reason to them. The physicist, with his facts, seeks reason; the biologist seeks something very much like rhyme, and rhyme is a kind of analogy. A man's arm, the front leg of a horse, the wing of a bat, and the flipper of a whale — look at them carefully with some imagination, and very clear and beautiful analogies appear, for they all have the same bones, in the same order, modified in various ways. (The biologists would speak of "homology" here, and keep the word "analogy" for other kinds of resemblance, but he is using words in a special, technical sense.) A human fetus shows clear analogies to a fish, and by a more vigorous exercise of the imagination a biologist can see part of the human ear in the jawbone of a fish. This analogizing, this fine sweeping ability to see

likenesses in the midst of differences is the great glory of biology, but biologists don't know it, and they praise themselves for the wrong reasons. They have always been so fascinated and overawed by the superior prestige of exact physical science that they feel they have to imitate it, and they solemnly announce that what they are doing is "framing hypotheses" and "testing" them, in the manner of the physicist.

Continuing their slavish imitation of physics, biologists feel that they have to give neat precise definitions of their terms. The results are ludicrous. It is extremely difficult to define "life" — fortunately it is not at all necessary. "Stimulus" and "response" are defined in terms of one another. No biologist can define a *species*. And as for a *genus* — all attempts come down to this: "A *genus* is a grouping of species that some recognized taxonomic specialist has called a genus" — no kidding, it really is that.

Biology is one vast mass of analogies, very different indeed from the cold logical thinking of the physicist. In the higher reaches, such as genetics, biochemistry, neurophysiology and other "ologies," biologists do some making of hypotheses and testing them against experiment, although even there they are apt to talk of "understanding in terms of . . .", or of "stressing this, or that, aspect. . . ." In its central content, biology

is not accurate thinking, but accurate observation and imaginative thinking, with great sweeping generalizations. "The Unity of Life" is a catch phrase they are addicted to, although this can hardly be regarded as confirmed by experiment, because it is almost impossible to say what it means, if indeed it has any meaning at all.

By far the most sweeping, and by far the best, of the great generalizations of biology is the Theory of Evolution, if it can be called a theory that has by no means been tested by experiment. It would not be possible, of course, to go back into distant geological ages to find out what actually did happen, and so the theory is only susceptible of a very limited kind of testing, anyway, by seeing what happens *now*. Biologists have been breeding *Drosophila* (banana flies, their favorite creatures for this kind of work) for thousands and thousands of generations; they have made flies with red eyes, short wings, hairless, dwarfed, stunted, and in other ways so modified as to be hardly like flies at all, and they have never succeeded in evoluting Drosophila into a fly of a different species, much less into any more distant creature. But scientists have been saying, to themselves and to the outside world, "Scientists always test their theories by experiment," so often that by sheer dint of repetition it has come to be believed

by everybody else, and even by the scientists themselves.

What is the theory of evolution? It is very easy to find out in a vague way, but very difficult to find out in a precise way. This is because it is really two theories, the vague theory and the precise theory. The vague theory has been abundantly proved, with an overwhelming mass of evidence, so much that it cannot possibly be doubted. The precise theory has never been proved at all. However, like relativity, it is accepted as a faith.

Vague evolution is rather difficult to formulate, because it is vague, but it is extremely easy to see. Any book on biology is full of it, and it has been so thorougly popularized that there is hardly anybody who is not aware of it. It points to the striking similarities, in every detail, between the bodies of men and of the apes; to the slightly more distant resemblances between men and other mammals, to the duck-billed platypus, which Huxley called "a museum of reptilian reminiscence," to the reptiles themselves, to the fish, both bony and cartilaginous, and so on and so on, as can be found in many a fine book. It points, too, to the development of the embryo, "climbing up the family tree," and to the record of the rocks — there were fish before there were reptiles, reptiles before mammals. Whatever this

proves — and it would seem to prove that all form of life are connected in *some* way — is indisputable

But in what way? To answer this question, w need a precise theory.

The precise theory of evolution is that all form of life on the earth today came from some origina form of life by a series of changes which, at ever point, were natural and *explainable by science.*

Now, as G. K. Chesterton has pointed out, th reason why evolution has always inspired suc intense popular interest ever since the days of Da win is that it is not a purely scientific theory, bu one that involves morals, that is, human behavio It is quite different from, say, the theory that th earth revolves round the sun or the sun round th earth, because, in the last analysis, it is of very littl human importance which goes round which. Th question at issue with the precise theory of evolutio is whether God gave things a sort of evolutionar shove every now and then (or perhaps all the time or whether He just wound things up in the begi ning and let them rip. God is involved in either cas unless you can believe that things wound themselv up, but the important point is whether God "inte feres," as it were, with what goes on on this earth, whether He leaves it alone. Biologists never ta about God (or at least only on Sundays, when the

are off duty) for it is considered unseemly for a scientist to do so. With this limitation they can never discuss the implications of evolution properly, and by mixing up the vague theory of evolution with the precise theory, they give the impression that both have been proved, whereas the precise theory is much further from being proved than men are from flying to the moon.

As regards the evidence for precise evolution, since evolution is a very touchy subject, it is best to let biologists speak for themselves. Here is Professor Bateson. "It is easy to imagine how Man was evolved from an Ameba, but we cannot form a plausible guess as to how *Veronica agrestis* and *Veronica polita* were evolved, either one from the other, or both from a common form. We have not even an inkling of the steps by which a Silver Wyandotte fowl descended from *Gallus bankiva,* and we can scarcely even believe that it did."* To the grand and glorious viewpoint, evolution is as easy as can be, but on getting down to actual details, difficulties begin.

Professor J. Arthur Thomson put it this way: "Many of the genealogical trees which Haekel was so fond of drawing have fallen to pieces. Who can

* *Concerning Evolution,* by J. Arthur Thomson (New Haven: Yale University Press). Reprinted by permission.

say anything, except in a general way, regarding the ancestry of Birds or even Vertebrates? *The Origin of Species* was published in 1859, but who today has attained to clearness in regard to the origin of any single species?"* And yet the more this scientist comes to the conclusion that he knows nothing precise about evolution, the more firmly he is convinced of it, "as a modal formula," he is careful to point out, as if that meant anything more than a smoke screen behind which to have things both ways. The genealogical trees intended to show how modern animals were evolved are familiar enough. If they show any animal as descended from any particular animal (except in a very few restricted lines), they are fudged. Animals are not descended from actual animals, only from hypothetical "ancestors." The trees will show a number of branches, and on the tips of the branches will be man, the great apes, the other mammals, and perhaps if it is a comprehensive tree there will be birds, reptiles, amphibians, fish and possibly other things. There ought to be a whole series of animals, going up the main trunk, and out along all the branches, up to the tips where the modern animals are to be found. There aren't any. Haekel's trees have indeed fallen to pieces, for the wood that should support them was all hypothetical

* *Ibid.*

wood. And yet they keep on making their appearance, in book after book intended for instruction.

J. Arthur Thomson also discusses the question of how life began. He examines various ideas, such as that it came from another world (which begs the question), or that it started of itself. Also another — which he thinks is a different one — namely, that God made it. Or as he puts it, quoting from some would-be spinner of magic words, "protoplasm is a handful of dust that God enchants." He recoils from this in horror, because he thinks it "implies a premature abandonment of the scientific quest."

Professor W. R. Thompson is a biologist who has a lucidity based on a scholarly knowledge of the much-despised Aristotle. If he used the word "modal" he would certainly know what it means. "That evolution has been gradual and continuous," he says, "is an induction based on certain particular cases, such as the horse and the elephants; it does not clearly emerge from the paleontological record taken as a whole." Also, "The Darwinian doctrine has thus been used, not as a working hypothesis, in the strict sense of the word, but rather as an explanatory principle which it is sufficient to illustrate by example, rather than to verify."*

* W. R. Thompson: *Science and Common Sense* (New York: Longmans, Green & Co., Inc.). Reprinted by permission.

To quote just one more biologist, R. S. Lull, Professor of Paleontology at Yale: "Since Darwin's day, Evolution has been more and more generally accepted, until now in the minds of informed, thinking men there is no doubt that it is the only logical way whereby the creation can be interpreted and understood. We are not so sure, however, as to the *modus operandi,* but we may rest assured that the process has been in accordance with great natural laws, some of which are as yet unknown, perhaps unknowable."*

And so biologists continue to "rest assured." But one may be tempted to ask, if some of the great natural laws are as yet unknown, how do we know that they are there? And if some are perhaps unknowable, how do we know that they are "logical"?

It is not fair to blame biologists for the phrase "the missing link"; reputable biologists have always disapproved of it. It is a most misleading phrase, because it suggests that only one link is missing. It would be more accurate to say that the greater part of the entire chain is missing, so much that it is not entirely certain whether there is a chain at all. With every new discovery of a fossil man or subman, the genealogical tree gets more complicated until it be-

* *Organic Evolution,* by R. S. Lull (New York: The Macmillan Company) © 1929, 1947, Reprinted by permission.

gins to resemble chain mail, with a great many links still missing. Any prudent, unprejudiced layman would conclude, "It may be that the biological origin of man will eventually become as clear as that of the horse, or the elephant, or it may be that it will not. Let us wait and see." Biologists are not so cautious. They have an unshakeable faith in What Science Is Going To Do Some Day.

A curious change in tone has taken place since the days of Darwin and Huxley and Herbert Spencer. These nineteenth-century giants spoke in terms of "survival of the fittest," an expression which is played down nowadays. This is done partly for legitimate technical reasons; the early Darwinians had overemphasized it, and there are other factors that must be taken into account in evolution. But it is also played down for hidden reasons. "Survival of the fittest" led to the concept of "nature red in tooth and claw" and this is not sufficiently wishy-washy for modern scientists. They prefer to express themselves in milder terms — certain mutations have "survival value," or, to make it still more long-winded, "have positive survival value." In any case those survived who were the fittest to survive, so that the meaning of this is the survival of the fittest all over again, but without sounding so harsh. The word "value" is greatly prized by scientists on account of its ability

to put the reader off the scent — but more of this in later chapters.

Why should one bother about biology? It is rather difficult to say. Of course if the question were asked a bit differently, Why should one study animals?, the answer would be quite clear. Animals are inherently interesting. Some people are more interested in them than others, but it is a horribly blasé, citified person who doesn't feel the faintest glimmer of interest when he sees a wild animal in nature. Children, who have not had time to become blasé, are always interested to see a live animal. Indians, and savages, who have not become citified, are wonderful observers of animals, and know a great deal about them They do not know the same things as the official biologist knows, but they know the habits of animals, and are able to trail them, and to construct ingenious traps for them, based on an accurate and detailed knowledge of their habits. But regular biology, as an "ology," has to be "scientific," and this means in practice that it has to be made dull. Thallophytes bryophytes pteridophytes spermatophytes — the Shorter Catechism of the Botanist.

Of the reasons why biologists think that their subject is worth studying one of the most important is to inculcate a detached way of looking at things, which is about all that is left of the scientific method

as practiced in physics. This results in that peculiar jargon, which contributes largely to making official biology as deadly dull as it is. Everything has to be expressed in utterly impersonal terms. If a squirrel stores away nuts, it is not in order to provide for the winter, as one would naturally suppose, but in response to a reflex initiated by the colder weather, or the shorter days. If a caterpillar or any other creature moves toward the light, that is phototropism; if it moves away from the light, it is negative phototropism; and similarly there are geotropism, chemotropism, thigmotropism and the like for various other movements. If you tell your dog to come, you call forth in the animal a conditioned reflex. Heaven forbid that a biologist should say that a chicken crosses the road because it wants to get to the other side: that would be unscientific; the whole matter must be "understood in terms of stimulus and response." "Hunger is one of the drives which causes experimental rats to become active."* "Although other sensations have various degrees of hedonic tone, pain is notoriously unpleasant."†

The explicit purpose of all this is to be "scientific," as science is understood by biologists, but there is

* *The Human Frontier,* by Roger J. Williams (New York: Harcourt, Brace and Company, Inc.)

† Reprinted by permission from Introduction to Psychology by Boring, Langfeld & Weld, published by John Wiley & Sons, Inc., 1939.

also an implicit purpose, which is very seldom openly expressed, and consists of inculcating a particular "ism," which may be called "materialism," or "mechanism," or "determinism." It does not much matter what it is called. It was well expressed by Alexis Carrel, who complained that men "have not understood that their body and consciousness are subjected to natural laws, more obscure than, but as inexorable as, the laws of the sidereal world."* — A very terrible statement, if true, for it amounts to a denial of free will. But how are we to know if it is true? If scientists have not yet discovered these laws, how do we know that they are so inexorable? But if it be objected that Dr. Carrel was a crypto-fascist, and that what he says is tainted at the source, here is what is said on page one of the first chapter of *Genes and the Man*, by Bentley Glass, Associate Professor of Biology at Goucher College: "Every characteristic of an individual can result only from the interaction of hereditary and environmental factors."† According to this it is not possible for an individual ever to do anything *for himself*. Every time you exercise any determination, or use your "free will" in any way, you deserve no credit for it (nor blame if you fail to do it), for it

* *Man the Unknown*, by Alexis Carrel (New York: Harper & Brothers). Reprinted by permission.

† Reprinted by permission of Bureau of Publications, Teachers College, Columbia University.

only results "from the interaction of hereditary and environmental factors." If ever you hear statements such as these of Carrel and Glass, the best answer is first to say very loudly *nonsense*, and then to challenge the scientist to prove his statement. It will turn out that he has no trace of a proof of it, and the whole thing is just another example of What Science Is Always Going To Do. Or rather, of What Science Has Given Up Trying To Do, for the physicists, we saw, have given up determinism, but this has not yet seeped through to the biologists (although they think it has). Determinism is singularly inappropriate in biology, for it amounts to looking at live things as if they were dead, but the biologists continue to think deterministically, simply because, being scientists, they do not know how to do any better.

Many biologists, and educationalists, think that in teaching biology they are following the old advice, "Know Thyself." They arrange courses for this purpose that lead to a considerable knowledge of the anatomy and physiology of the human body. This is very interesting in its way, and very useful for preserving one's health: so is physical exercise useful for preserving health, and so, too, are courses in dietetics, shading into cookery. Physical exercise should always be taken, in appropriate doses, alongside of education, but no one thinks that physical exercise *is*

education. The one trains the body, the other the mind. Studies on the human liver do very little more to train the mind than intelligent studies in cookery, and they are not nearly so good for the health of the liver as a good game of basketball. The body is not the first concern in education. Well-trained athletes are not notorious for being well educated. If you study man's body, then you are making very little progress in knowing yourself. For man is not his body, any more than an orange is orange juice or a home is a bedroom. "Know Thyself" means a great deal more than "Know Your Body."

Yet another reason why biologists think that everyone should study biology is because of a deep conviction they have that man is an animal. Study animals, they say in effect, and you will learn about man. You will learn that man is in the phylum Chordata, in the class Mammalia, and in such and such a division of the same. This is called "understanding the place of man in nature." Man is sometimes described as "one of the animals in a community of organisms," although this gives quite a stretch, nay a violent yank, to the meaning of the word "community." Mosquitoes are also organisms in this alleged community, but since we would never do a thing for mosquitoes unless we ourselves were to benefit from it, our behavior toward them is decidedly uncommunal.

Some biologists carry this man-animal analogy very far; since biologists deal constantly in analogies, they are easily misled by them. They will, for example, give alcohol to rats, or guinea pigs, to observe the effects. These rodents have weaker stomachs than we have, and so in order to make the experiment quite fair, they have to be given the smell, not the swallow, of the alcohol. The results were very bad, for the offspring of the tipsy creatures were puny, weak, and in every way worse than "untreated" animals. On the other hand, alcoholic fowls had offspring that were actually *better* than the controls. And surprisingly enough, when the rodents were bred through for several generations, always with the smell of alcohol, better rats, and better guinea pigs, were produced. It is believed that the alcohol eliminated the weaklings, so that only fine sturdy animals survived. But the man-animal analogy cannot be stretched to provide any moral to this story, because, although a biologist can recognize a better guinea pig when he sees one, he has no idea of what makes a better man.

Some ultra-scientists have tried to gain an inkling of what man *should* do by observing what animals *do* do. They solemnly observe that all animals strive toward survival, or at least, taking into account a female animal fighting to preserve its young, for the

survival of the species. This merely leads to the illuminating conclusion that man should strive for the survival of his species. All animals are adapted to their environment. Therefore man should be adapted to his environment. And yet even this conclusion, feeble as it is, is not strictly valid. If we regard the matter with extreme objectivity (which is supposed to be a virtue in science) we must note that *not* all species of animals are adapted to their environment, and *not* all species of animals survive. Some become extinct. If we observe animal life with true detachment, we note that some animals survive, some become extinct, that is all. Which should we imitate? In all probability the human race will decide to survive, if it can, but there is no *scientific* reason for this decision.

Man is not an animal. He is a thinking animal (and a laughing animal, and an animal that builds temples, and has incest tabus). Is a unicorn a horse? A unicorn is a horse plus a horn, and not a horse. Man is an animal-plus-something — the ability to think, and the ability to think makes far more difference to what would otherwise be an animal than a mere horn would make to a horse. Oh yes, there is a sense in which a man is an animal, but there is also a sense in which he is not. There are men, and there are animals, and they are different, and to say just "animal,"

without the qualification "thinking," is not to include man. Biology can tell us about animals, which are interesting for their own sake; it can tell us about our bodies, and this is interesting and extremely important; but there are grave gaps in what it can tell us about man.

Animals feed and reproduce. Some men behave like animals, others do not. There are some people whose lives are pretty well limited to feeding and reproducing, but there are others who are completely different, and utterly different from any animal. There are men, and women, who deliberately refrain from reproducing. There are people who lead lives of extreme asceticism, and love it. Admittedly they are few, and they are saints, but people who emulate saints in some slight degree are very many indeed. And yet, a scientist has been sufficiently befuddled by the man-animal analogy to say: "What I know of biology leads me to believe that our conduct is in reality motivated by one paramount and vital aim, not different, objectively considered, from that which is the single end of all animal existence. That aim, in a word, is comfort."*

The necessary and sufficient answer to this is, "Flapdoodle."

* From *Science and Good Behavior,* by H. M. Parshley, copyright 928, used by special permission of the publishers, The Bobbs-Merrill Company.

Chapter V

THE PROPER STUDY – PSYCHOLOGY

If the proper study of mankind is man, then biology is only part of the story, and not the most important part. The other part is "psychology," which comes from the Greek word meaning soul, and would be clearer, but not more elegant, if we called it soul-ology.

There is nothing mysterious in saying that man has a soul. Think of yourself, are you your body? It is your" body: the "you" that has the body is your soul. Mystery comes in if we discuss whether man has an *immortal* soul; this can be, and is, disputed, but you are not committed to any belief on *this* subject merely by realizing that man has a soul. The body has weight, the soul does not: this is a perfectly clear distinction between the two.

In the old days a hard-boiled materialist surgeon could use his knowledge of anatomy to disprove the soul, saying that he had never met it in any dissection. Nowadays no such thoroughly definite attitude

is taken. Psychologists study the soul, but they are reluctant to tell you clearly what it is they are studying. A man is a composite, of body *and* soul, and the definition of "soul" was given quite clearly, by Aristotle — but this was a long time ago. Psychologists, like other scientists, pride themselves on being extremely modern, and therefore much better than any group of people that ever were before, and they have discovered with an air of astonishment, what nobody in his senses ever doubted, that the soul and the body have the most profound effects on one another. Being fundamentally muddle-minded, upon noticing this close connection between the body and the soul, they suppose that they *are* the same thing: "The physical and mental aspects of man," they will tell us, "cannot be separated." They *can* be separated, of course, by killing the body, but the process is drastic and irreversible, and it is seldom necessary to do it, and we can see that they are different quite easily by considering such a remark as "He was in the classroom, but his mind wasn't on the job. It was out on the playing fields."

Psychologists, following the biologists, who are themselves following the physicists, feel that at all costs they must be objective. Therefore they study man in a detached sort of way, as if they were not men themselves. Mr. Sidney Hook has seriously won-

dered (in *Education for Modern Man*) whether man is intelligent. He says this is an empirical question on which considerable evidence has accumulated. One would think that Mr. Hook, having made the acquaintance of some men, would know whether they are intelligent or not. But no. Scientific reserve demands the cautious statement that "evidence has accumulated." But how does evidence accumulate? Does it lie around in a sort of dustpile, or does it accumulate in minds, and if so, don't the men have to be intelligent in order to take in the evidence? Perhaps it would not be too outrageously daring to conclude that "at least some men possess at least some intelligence." Mr. Hook might have come to this conclusion by contemplating himself. But here is the point – by the rules of the scientific game, he is not allowed to contemplate himself. To do so would not be objective. It would be subjective. It would be using *introspection,* a procedure which is regarded with the darkest suspicion by all true scientists.

It is easy to study objects objectively. If the object happens to be alive, that will not stop us, for we can be thoroughly objective about an amoeba, or a chimpanzee. We can also study another man as objectively as we please. We can be objective about our thoughts, and we can even achieve miracles of self-analysis and be objective about our own emotions.

But why should we? If it was worth doing with a stone, it does not follow that it is worth doing with a man. A savage considers a stone, or an animal that he wishes to feed on, or anything else in the world, animistically, attributing to it desires and feelings similar to his own. That is why savages are excellent biologists, in a certain practical way, and extremely poor physicists. A stone does *not* have feelings, and it is only possible to make progress in studying stones by painfully disregarding all feelings and being objective, the classical method of physics, the classical science. A man does have feelings, and you throw away your best chance of understanding him if you deliberately forget that his feelings may be very similar to yours. If you make a man angry, you know what he feels like, for you have had the experience of being angry yourself. A chimpanzee has feelings, and you know quite well what is going on when a pet chimpanzee is sulking in a corner because you have "hurt his feelings," or when he is jealous of attention paid to someone else. (The chimpanzee has a soul, too, by the way, but this soul does not have all the powers that the human soul has.) It is perfectly possible to be objective about an angry man, but it is inadvisable, for it will only make him angrier. What happened to you, yourself, the last time you were angry? Did somebody manage to soothe you? And how was

it done? A truly objective psychologist (if there ever was, is or will be such a person, or rather such a monster) would not be able to ask himself these illuminating questions, for this would amount to *introspection,* that naughty word. He would have to proceed by the scientific method, trying this and that in a systematic manner, until the angry man had smashed the entire laboratory.

Studying men is entirely different from studying sticks and stones and other physical objects. In studying sticks and stones there is nothing for it but to cultivate the true scientific detachment, observing and recording, without bias, what happens under such and such circumstances, and then making hypotheses and testing them by experiment. But when we study men – we are men ourselves, and this gives wonderful opportunities for understanding what we are studying, but not by the method of objectivity. Thus psychologists find themselves in a quandary, for the more scientific they are (understanding "scientific" to be the same as "objective") the more blindly they must close their eyes to the best way there is of finding out about men. And so, although science is supposed to be "that realm of human thought in which universal agreement is possible," psychologists are broken up into a large number of "schools," depending upon the particular

compromise they make between extreme objectivity and the abandonment of the official scientific method. So far from there being any universal agreement, there are (or have been) behavioristic psychology, Gestalt psychology, normic psychology, functional psychology, act psychology, structural psychology, response psychology, dynamic psychology, reflexological psychology, and, to inject a note of left-wing politics, a psychology of dialectical materialism.

Away off at one end of the scale are the nonexperimental psychologists, represented by the famous trio of Freud, Adler and Jung, and by all the psychiatrists. (A psychiatrist is a person who tries to cure sick souls. He is to a psychologist what a physician is to a physiologist. A psychoanalyst is a psychiatrist who uses a particular long-winded technique, invented by Freud.) Freud has the human soul divided into the Ego (the ordinary consciousness), the dark, amoral Id, and the Superego. He didn't discover these things by any objective methods. No scientific test, and no instrument, can ever detect the Id. Freud simply declares that they are there. He bases this on what he has learned from people, not under strictly reproducible scientific conditions, by experiments which anyone else can verify, but in the extreme privacy of the consulting chamber. The necessary relationship between patient and psychi-

atrist would be spoiled if there were any snooping scientists around, trying to verify and confirm the results. No experiment ever showed Freud that certain objects commonly appearing in dreams are sexual symbols, and no experiment can confirm that they are. The whole idea is based not on rational deduction from experiment, but on insight, and that is why it is so much more illuminating than anything that the strict scientific method can tell us about the human soul. Some of these nonexperimental ideas have been taken up by everybody, psychologists and "laymen" alike, and we all talk about the subconscious (Freud), inferiority complexes (Adler) and extroverts and introverts (Jung). Insight is not the same as scientific deduction, but even at that it may be more reliable than statistics.

The run-of-mill psychologists belong to various groups, differing somewhat according to whether they "see things" this way or "emphasize" the other aspect. They allow introspection in an objective sort of way. The subject of one of their experiments is allowed to say, "I see a red after-image," or "There is a buzzing in my ears," but nothing so downright personal as "I hate your guts," or "I love you." They cover an enormous field, ranging from a detailed study of all the senses to personality classification in terms of ascendance or submission, eidetic imagery,

evaluative attitudes or atypical opinions. They reach out a hand to the neurologists (biologists who study the nerves), for they hope to explain the actions of the soul by means of those of the body, and the brain and the nervous system seem to be the most appropriate parts of the body to begin on. They will tell you about neurons, axons and dendrites. A neuron is a nerve cell, and though it is minute, the axon that sticks out of it may be several feet long, and it also has a number of smaller, branching projections, the dendrites. The dendrites of one neuron often come up against the axon of another, and the place where they touch is called a synapse. Some neurons bring sensory messages *in*, others bring motor messages *out*. A reflex arc, a thing very dear to an experimental psychologist, consists of a neuron which brings in a sensory message, transmits the impulse to another short neuron in the brain or spinal cord, which then transmits it to a third neuron from which an impulse goes for a muscle to move. Sometimes instead of one intermediate neuron, there are quite a number, connected every which way by their branching dendrites, so that the nervous impulse could have a wide choice of paths. The reflex arc may explain the actions of very simple animals, and some very simple actions of higher animals, such as a dog scratching his leg when you touch him in a certain place. It is

not within a million miles of explaining what human beings do. The nonexperimental psychologists, who have developed some really useful human insights, have done so without any regard to neurons and synapses. But Professor Clark L. Hull tells us that nearly all serious students of behavior like to believe that some day the major neurological laws will be known in a form adequate to constitute the foundation principles of a science of behavior."* The optimism of scientists is truly boundless!

At the other end of the psychological scale are a waning group called the behaviorists. Led by J. B. Watson in the teens of this century, they made a really valiant effort to be *thoroughly* scientific. They were not going to allow *anything* that came from introspection. No thinking, no feeling, no sensation even, *nothing* but behavior. They received considerable impetus from Pavlov's earlier work on dogs, on the well-known conditioned reflex. Dogs are ideal for a behaviorist, for *if* they think or feel or introspect, at least they cannot tell us so. Pavlov connected dogs to an ingenious contraption which measured the amount of saliva they produced on hearing a bell which they knew from experience was the dinner bell. The same experiment was performed on human

* Hull: *Principles of Behavior* (New York: Appleton-Century-Crofts, Inc.) © 1943. Reprinted by permission.

beings, and it was found that their mouths, too watered when they received an auditory stimulu which had become associated with eating, showing that men, as well as animals, can have a conditioned reflex. Animals, as we saw in biology, are supposed to be "understood" in terms of stimulus and response the behaviorists determined that they would under stand human beings in the same way. The problem of the behaviorist was, given the stimulus, to predic the response, or, given the response, to "predict" (a Watson called it) the stimulus. Speech is a verba response to a stimulus. There is no such thing a thought, only "voiceless verbalization," or "sub audible pharyngeal activity," or something of th kind. Children should be educated by "condition ing" them to this or to that, and grownups could b improved by "re-conditioning" them. Bad men wer to be made into good citizens by this means, an eventually we would all live in a smooth harmoniou reconditioned millennium. Naturally it has neve taken place.

The violent squabbles between psychologists o different schools are largely a thing of the past, an nowadays they get on much better with one anothe It has even been possible to make a list of funda mental postulates on which psychologists are sup posed to be agreed. One of them is "Human behavio

may be, and has been, interpreted from different viewpoints, no one of which is necessarily right or wrong, and all of which may contribute to complete understanding." Another is the usual conventional utterance of the scientific creed, "No interpretation of human behavior can be fully accepted unless it is founded on fact substantiated by scientific evidence." Psychologists like to believe that they base their conclusions on fact substantiated by scientific evidence, but they don't, for another two of their postulates are: "All human behavior has a cause" and "Potentially, all human behavior can be measured and described."* There is *no* experimental proof of these interpretations. Some human behavior may have a cause, and some can be measured and described, but these sweeping statements about *all* human behavior are nothing but a pious hope. Psychologists pay lip service to the scientific method, and use it whenever it is convenient; but when it isn't they make wild leaps of their uncontrolled fancy, and still suppose themselves grounded firmly on objective fact. For example, Professor Gardner Murphy tells us in the foreword of his textbook on psychology: "For what it may be worth, I venture to put down here the few doctrines or opinions which

* "The Basic Postulates of Psychology," by W. Edgar Vinacke, *The Scientific Monthly*, August 1948. Reprinted by permission.

I regard as fundamental in the present text, emphasizing that despite the incompleteness of evidence I feel these principles to be in a sense the framework with reference to which all the details may be seen."* What a scientist! Imagine, if you can, a physicist saying anything like this. The psychologist knows the evidence is incomplete, but he just *feels* what is right!

If you really want to understand human beings, there are plenty of people to go to besides psychologists. There are men, and women, who have a wonderful understanding of human beings, without having acquired it by any official scientific procedure. Most of these people are incapable of communicating their knowledge, but those who can communicate it are novelists. They are good novelists precisely because they are good psychologists. But they are not scientific psychologists: they are in a sense poets, and many of the poets (but not all) are first-rate psychologists. If one wishes to learn about psychology in a genuine, rather than a scientific, way, by far the best thing to do is to read masterpieces of literature. Educators realize this, and they always allow room for just a little of "the humanities" in any curriculum, sometimes quite a lot. This has

* *A Briefer General Psychology*, by Gardner Murphy (New York: Harper & Brothers). Reprinted by permission.

driven some of the rabid science fiends, such as Professor Bobbitt, the "ology" fan, into a frenzy, for they can see no sense in anything but a solid diet of science science science from the age of fifteen on. The general feeling of mankind is against them, for everyone realizes that a person who has not read, say, at least one play by Shakespeare at least once in his life is, in a vague way, "uneducated," but the professional teachers of Shakespeare, who should know the real reasons for studying great literature, have not put their best foot forward, and have given feeble reasons, rather than good ones, for doing what everyone agrees ought to be done. "Cultural benefit" is a stuffed shirt's phrase meaning nothing whatever: translated it may mean no more than that it is nice to know the same quotations as other "educated" people, so that we can swap classical tags together, and make the mere uneducated people feel left out. A much better reason could be (but seldom is) phrased like this: "Reading Shakespeare is capable of giving some people a very great pleasure, but it is difficult, and hard work, to learn how to do it. Therefore it is worth while putting a classful of young people through the grind of 'doing' Shakespeare, on the off chance that a few of them, in their later years, may enjoy this great poetry." But if this were the real reason for literature, it would hardly

be good enough. If there were even a slim chance, as some scientists think there is, of avoiding an atomic world war by teaching people nothing but science, it would be worth while to throw Shakespeare, Dante, Homer and Cervantes into the ash can for ever. And yet nobody thinks of doing that, even in the jam we are in now. There are really important reasons for reading great literature, and one of them is that it was written by great psychologists.

Not that literature is taught as if it had anything to do with psychology. It is more commonly taught as if it had to do with "values" or "trends" or "forms." The professional literature men, who are if anything even worse than the scientists, will do everything with a work of art except try to find out what it means. They will "evaluate" a work, and then "re-valuate" it, and then write a "definitive" valuation which later on has to be re-valuated all over again. They will consider what Plato meant to the Greek world, or what Machiavelli meant to the Italian Renaissance, instead of considering what they mean. They will explain Milton until they explain him away. They will read great works "in the context of their time," without seeing that unless the book has something to say for our time, right here and right now, it isn't worth reading. Instead of considering the content — that is, what the writer actually says —

they will analyze the style, and for this purpose they will enter into alliance with the scientists, and devise means whereby the style of a writer can be tabulated and worked out by international business machinery, plotting graphs of rhythm and tone patterns, assonances and consonances, associational values and sequences of syllabic length.

Tom Sawyer's technique for getting the other boys to paint the fence for him is a very simple example of psychology in literature – in a book for children. It is so extremely simple that it can be, and is, used in teaching scientific psychology, for it is actually possible to say, in perfectly clear terms, what it was that Tom did that made the other boys so keen to spend their time painting. Great works of literature can hardly be summarized so easily. If it were possible to say what it feels like to be a murderer, or to be mad, Shakespeare might have said so, in clear terms. Instead, he wrote *Macbeth*, and the various studies in madness. Really great psychological insights cannot be simply expressed, as so many propositions; they can only be conveyed by parables, by telling stories. It is not likely that they will ever be "scientifically known" as the result of laboratory experiments on axons and neurons.

For a scientist an emotion is just an object of study like any other, and following Kelvin (not such a

good leader) they feel they have to measure it. It is not possible to measure emotions. It *is* possible, however, to measure bodily changes that go with emotions. For instance, if you were to break out into a cold sweat, a scientist might be able to measure the amount of sweat. If your hand trembles with emotion, the tremble can be measured. The heartbeat and the rate of breathing can be measured, and they change with emotions, and a very delicate measurement can be made of the electrical resistance of the skin (the galvanic skin response). These things have been measured by psychologists in painstaking experiments, and all that they are able to say is that changes do take place while the subject is experiencing an emotion. The pulse rate sometimes goes up, sometimes down; so does the respiration. The galvanic skin response varies all over the place, changing in an erratic and unpredictable manner, not only with emotions, but with other things as well. There isn't even any clear difference, as far as the instruments can tell, between pleasant and unpleasant feelings. We would have to ask the subject to tell us that — and this would amount to introspection! Gardner Murphy, leaning over backwards in objectivity, even asks, "Can the different emotions actually be distinguished from one another?", a question which is utterly absurd. It only goes to show

that emotions are being investigated by entirely the wrong method.

If even simple emotions elude investigation by gauges and recording instruments, what happens to our more complicated feelings? Hatred is akin to love – we all know this, but we didn't learn it from any scientist. The fascination of horror is one of the commonest experiences, but it eludes the galvanometer. For certain very human feelings it would not even be possible to use a galvanometer. Byron describes the seduction of a lady (a subject he knew well enough, unscientifically but successfully) concluding, "And whispering she would ne'er consent, consented." This lady was in a delightful state of mixed emotions, surely most interesting to a psychologist, but how could these emotions be "measured"? To connect the lady up to any kind of apparatus would ruin the intimacy of the scene.

In an attempt to get over the vast chasm between science, as the physicists practice it, and any psychology that is worth doing, it is fashionable nowadays to proclaim, with a smug air of having discovered something wonderful, that there is not just one Scientific Method, but Scientific Methods. Each science has it own method appropriate to its subject matter. Each science has its own "logic" even, sometimes its "internal logic," whatever that is, as if logic

were ever different from the plain ordinary old-fashioned logic. Science becomes simply "whatever scientists do" and a scientist is defined as a person who has received his Ph. D. degree in a subject commonly classified as "science." The rigid accurate thinking, which really does make physics such a valuable study, may be totally absent in some other science. A science may do without mathematics, if it pleases. It may even do without measurement, though scientists abandon this with reluctance. All that remains is objectivity, and the regular steps of the scientific method: observation, framing a hypothesis, and checking the hypothesis against the experiment. And even these steps are often qualified by an additional one, added at the beginning, to the effect that the scientist must ask the right sort of question, that is, one that can be answered by scientific means. This imposes a severe limit on psychology, because it can only give the answers to the sort of questions it is allowed to ask. What sort of things do we really want to know about a man? We might want to know if he is good company. A completely unscientific question — cut it out. Is he honest and reliable? Is he selfish? Is he materialistic? Is he given to old-womanish gossip? Is he catty? Would he stick by one in an emergency or would he knife you in the back? Could one tell one's troubles to him,

would he understand? Would he be helpful in a difficulty? Would he make a good lover? You will get very little help from a psychologist in answering these questions. You will get even less help if you want to know anything about really important human qualities, such as goodness, or holiness. A psychologist would be horrified at the thought of having to say anything about holiness (except on Sundays, which don't count). He has very little to say that is worth saying about courage, or for that matter, about humility, prudence, temperance, wisdom or any other virtues, although he has plenty to say about "ego-involvements." It is amazing, but true, that it is possible to go clear through a course in psychology without ever hearing what the various virtues are, and which are intellectual and which moral. "But there is no agreement about 'virtues'," the psychologists would surely exclaim, shocked in their scientific souls, if it were suggested that they should actually mention such things, to which it can be replied that there is no agreement about psychology either. There are very many points in psychology about which it is only possible to say: "Freud and his followers see this in terms of so-and-so, whereas the Gestalt group understand it as. . . ." It would be entirely possible to say: "Pride is a pagan virtue but a Christian sin," and let people take their choice. This would

not even amount to preaching from the professorial chair, a fault which the psycho-pedagogues like to think that they avoid. They do not avoid it, for however "objectively" they aim to present their story, they rarely fail to put in little plugs for Tolerance, Leadership, Salesmanship and (of all things) Aggressiveness — the four characteristic modern virtues — if indeed they are virtues. (Tolerance is better than intolerance, but charity is better still.)

It is typical of psychologists that although they have very little to say about the duties of man, they are strong on his wants, desires and needs. They enumerate these with great care. One such list gives eight of them: food, clothing and shelter; activity; effective effort; beauty; sex; security; prestige, and something which is quaintly called "service," meaning "to be of service to others," not, as one would obviously suppose, the sort of service one gets in a service apartment. There are other lists that differ somewhat from this one, but this, and many others, have an enormous and glaring gap, for they make no mention of one tremendous need felt by everybody, the craving to know. It is amazing that this particular list was taken from a book on *educational* psychology: the author must find his teaching very uphill work if he does not recognize, in himself and in his pupils, the basic need for Knowledge, for Cer-

tainty, the drive behind children when they continually ask Why?, the craving that religions have been satisfying for men since before the dawn of history, and incidentally, the motivating force for science itself.

Psychologists proudly claim that theirs is a useful science. So it is, *some of it*. It is not the intention of this book to deny or belittle the useful things that science has done, but neither is it necessary to say much here about the achievements of science, because there are so many science publicists already busy doing that. Psychology has a number of fine achievements to its credit; treatment of war-shocked soldiers, and far better understanding of some kinds of mental illnesses, are two outstanding examples, and some others are aptitude testing (now developed to a fine art), job analysis, psychology of advertising, attention-getting techniques, and methods of "motivating" other people. But for all the usefulness of these, the really important questions in human life are hardly touched upon at all by psychologists. Do liars come to believe their own lies? Advertising men their own bunk? Is pleasure the same as happiness? Is it better to have loved and lost than never to have loved, or not be able to love? Is there only one kind of love, or more than one kind, and which kinds are compatible with irritation? with anger? with fear?

with hatred of the beloved? You could take course after course in psychology, all offered in the name of the higher scientific balderdash, and in the end not be the least bit wiser about these desperately important and practical matters. And even on a lower plane of usefulness, the plane where the scientist is at home, you will not be likely to find a thoroughly practical little course in Sales Resistance, or in How To Get Rid of People and Avoid Being Influenced By Them.

Although psychologists have nothing in particular to say about love — their poverty in this regard, in comparison with poets, is uncommonly striking — they have very definite opinions about hate. They deplore it; they do not wish to advocate anything so "negative." "Authorities agree," says Roger Williams (Note the authoritarian scientist. He didn't say, "Experiment has shown." Scientists are great believers in authority; any authority as long as it isn't Aristotle), "that hatred is one of those reactions which are harmful both mentally and physically. It presumably releases poisons into the body, but whatever the mechanism, its bad effects are generally recognized."* Horrors! This is monstrous and utterly

* *The Human Frontier*, by Roger J. Williams (New York: Harcourt, Brace and Company, Inc.).

vile. The other aberrations of the scientists that we have met so far deserve no more than laughter – good loud laughter, for the scientists are pachydermatous – but this must be violently trampled down and stamped upon. It is our duty to hate. Not to hate people (which is probably the only kind of hating the stupid Authorities had in mind), for no man is so wicked but he has a trace of goodness in him somewhere, but to hate evil. We *must* hate evil, wherever we find it. Here again, the poets are wiser than the scientists, for many of the great poems are hate poems.

One should not hate a psychologist. There is probably plenty of good in him. It is probable that, hundreds of years from now, people will look back at our "objective" psychologists, with their reflex arcs and their stimuli and responses, in the same way in which we look back at the medieval schoolmen who are alleged to have debated how many angels could dance on the point of a pin. Psychologists can't ask the right questions, and they have given up (to a greater or less extent) the best way we have of understanding men, but with these limitations they are doing their best. The less scientific they are, the better they are doing. And since all of them pride themselves on their ability to reason, and most of them

have a tendency to be a little humorless, let them consider the following simple piece of reasoning: "There's many a true word spoken in jest"; scientists are abominably solemn; therefore scientists miss many a true word.

Chapter VI

THE SOCIAL ANIMAL

It is to the credit of educators, and even of most "educationalists," that they do not teach social sciences in the name of the higher baloney about the scientific method. Instead they teach social studies because they are obviously worth knowing about for their own sake. A dash of physical science, perhaps also a dash of biological science — these must be absorbed in order to inculcate that wonderful humility before the facts of nature that comes from close attention to a textbook, and that unwillingness to learn from Authority that comes from making almost verbatim lecture notes and handing them back to the professor. But when it comes to a little history, economics, government, sociology or even a smattering of anthropology, they just hand them out with no mystical "scientific" nonsense.

Among the social scientists themselves it is different. To begin with, only some of them call themselves "scientists" at all. Others are content to study history, and call themselves historians, or economics and call

themselves economists, without continually blowing their own horn about how "scientific" they are. They range, as the psychologists do, from the most scientific on the one hand to the most sensible on the other. The spread among them is even greater than it is among the psychologists. On the one hand the extreme science men have an aggressiveness and cocksureness hard to match, even among the psychologists. Since their subject matter, which is the relationships of men with one another, is even more vastly complicated than the study of any one man's soul, their confidence is of the nature of "the lady doth protest too much." At the other end of the scale are such people as, to take just one example, Mr. Walter Lippmann, who knows at least one branch of "social studies" extremely well, without giving himself any particular airs as a scientist. And if Mr. Lippmann were to claim to be a scientist the same claim could be made on exactly the same grounds by Messrs. Walter Winchell and Westbrook Pegler.

The social scientists would like to begin, as is appropriate for a scientist, with definitions. There is no agreement whatever as to what these should be Here, for example, is how Professor G. A. Lundberg begins this task: "The person is an individual who by virtue of his symbolic equipment behaves to some extent (e.g. 'in his thoughts') with reference to some

other person or persons. [Who ever heard of a person who didn't do this?] The most elementary unit of sociology is, then, the person, that is, the individual *with his societal conditionings.* Spykman following Simmel has called this elementary societal unit 'The Monad.' "* Later on we arrive at "the pair or the Dyad." And since Dyads sometimes reproduce we are bound, eventually, to reach what might be called the "Severalad," or "Familyad," although it isn't called this, because no sociologist ever bothers to use such words all the way through. A man, or a woman, can be called a man, or a woman, just as easily as a Monad, and nothing is gained by the highfalutin words.

Social scientists study men collectively, for they have realized that man is a social animal, or a political animal. If they study a primitive society, it is anthropology, if a civilized society, it is sociology, they mix in a little psychology and call it "social psychology," and they also reach out to the respectable ancient studies of history, economics, theory of government, etc., and confound them all in the glorious new thing called Social Science — if indeed it can be called a science, for this is disputed by many. Actual Science, with a capital S, is practiced by relatively

* G. A. Lundberg: *Foundations of Sociology* (New York: The Macmillan Company) © 1939.

few. The rest of them are for the most part perfectly sensible, and in many cases entirely admirable. These are the good ones, and if they sometimes describe what they do as "social science" in a vague way, for want of a more convenient term, we should not hold it against them. But if words are used accurately, a "social scientist" is a "Social Scientist," and that denotes one of a small but highly vocal group who think they have something entirely new in the world, something better than anything that ever was before. All that is new in this way of doing things is the scientific attitude of detachment and objectivity. It amounts to looking at man through the wrong end of a telescope, and pretending that it is a dissecting microscope. And if some of the results of this tele-microscopic method are less than epoch-making, its proponents candidly admit that their science is in the pre-Galilean stage. At present they are energetically assembling great quantities of facts, and they are waiting for a Galileo or a Newton to set up some "Laws," or establish conceptions, by which the whole thing will tumble together and make a tight logical system like physics. No one has done this yet, or comes anywhere near doing it. The claims of these studies to be a science are based on What Science Hasn't Yet Begun To Do.

Scientists are at any rate not lazy, and the social

scientists are as industrious as bees. Pending the arrival of the social Galileo they write papers such as "Developing Demoscopes for social Research" — "The relationship of population density to residential propinquity as a factor in marriage selection" — "Questionnaire versus interview methods in the study of human love relationships" — "Sample of 1001 remarks overheard in Manhattan." Professor R. T. Lapiere of Stanford University describes the activities of a social scientist as "obtaining from large numbers verbal expressions, — opinions, attitudes, beliefs, values, or knowledges, depending upon how they are secured and to what they are related — and correlating these verbal expressions with the socio-economic status, the age, the sex, and the various actions of those persons."* A Correlation is something almost sacred; as soon as he finds one, however unimportant, the social scientist considers that he has benefited mankind by adding to the sum total of knowledge that is scientifically known — anything known otherwise than scientifically, of course, he doesn't consider at all. A team of social scientists once made one of their typically elaborate investigations into the problem of why, in a certain town, waves of naughtiness would periodically occur among all the

* *Sociology*, by R. T. Lapiere. © 1946. Courtesy of McGraw-Hill Book Co., Inc

small boys simultaneously. They recorded everything conceivable, and matched things up every which way looking for a correlation. At last they found something that correlated — the waves of naughtiness coincided with the appearance of Superman at the movies.

Sometimes, of course, the correlations are rather more important than that. Correlations can be made of people's votes, or their opinions on anything under the sun, with their income group, color of hair, racial origin or anything else, and the results may be exceedingly useful. But this does not make them a science. There are plenty of reasons why the "social sciences" aren't science at all. One of them is that there isn't anything fixed, or constant, about what they are studying. Other sciences are in sharp contrast: they study something that is definite, and stays put, so that knowledge concerning it can accumulate. A physical scientist measures, say, the melting point of copper: copper is just copper, the same yesterday as today, and methods of measuring melting points have been decided upon so that they, too, do not change. Even the biologist studies something comparatively definite; if he studies ants, ants stay the same with exceedingly little change, year after year. But what does a sociologist study? Man — a creature so infinitely variable that there is no resemblance

worth mentioning between the sociologist and the physicist. A sociologist can never specify the object of his study as "copper," or "*Camponotus pennsylvanicus*" (one of the species of ant). Instead he has to say, "This investigation was made on a group of 1073 high-school children from 14 to 15 years of age in south-central Illinois," with the perfectly clear understanding that it might be different for children under 14, or over 15, or even in other parts of Illinois, and finally that it may no longer be true next year, or even tomorrow, for social conditions may by then have changed in south-central Illinois. The scientists seek to overcome this difficulty by immense assiduity. If they really want to know whatever the investigation was to investigate, they have to persuade someone to provide funds for further investigations in northern Illinois, or even Wisconsin, and then for additional investigations on children of 15 to 16, and so on and on with literally no end to it. Dr. Kinsey's celebrated report is mistitled *Sexual Behavior in the Human Male*; it should be "Sexual Behavior in the American Male"; or better, "The Sexual Behavior of 5300 Men Who Were Willing To Talk About It"; or better still, "Sexual Behavior of Some Men Who Have No Shame."

There is even a further awkwardness about this ort of investigation, and that is that even "all" the

data still aren't the end. Suppose, for example, that some incredibly ingenious scientist, with an army of researchers, were to find out all the necessary and sufficient social causes for getting, say, an Oedipus complex: still his results would apply only to the type of society in which he did the work. As the anthropologists have shown, they would not apply in the least to the Trobriand Islands. Quite possibly they would cease to apply, even in the same place, within one generation, for there may be plenty of social change within one generation. It is entirely possible that the results would cease to apply the day after the scientist published his researches. And, for example, sometimes important data cannot possibly be obtained, for example, "the number of undetected crimes."

This sort of thing leads those who practice the social studies sensibly to make no particular claim to be scientific in the same sense as physical science is scientific. Their subject is extremely variable and complex, and they know it; they study it as well as they can, and leave the scientific blah to other people. But to the real science fiends, difficulties like this are merely a challenge; once they are determined to say that what they do is scientific, they are going to say so anyway, and to think up reasons, good or bad, to back themselves up. The core and essence of the

scientific method, they will say, is framing hypotheses and testing them by experiment, and so they have worked out techniques for making what they do appear in the guise of framing and testing hypotheses.

One easy way to do this is simply to *say* that you have a hypothesis, and that it leads to such and such conclusions, regardless of whether it really does lead to them, or whether it can genuinely be said to "lead" to any conclusions whatsoever. You only have to take care that the conclusions you say it leads to are in agreement with some investigation that you, or someone else, has made. It is all so much easier than in the physical sciences, where there is a tradition that a hypothesis shall lead to certain definite conclusions, arrived at by logical thinking, so that men cannot disagree on what *are* the consequences of any hypothesis. The theory that gravitational attraction is inversely proportional to the square of the distance leads by relentless logic to the conclusion that the path of a planet should be an ellipse, and not a figure-eight or an egg shape or any other curve. It is this logical thinking that is the real meat of the physical sciences. The social scientist keeps the skin and throws away the meat. When a social scientist decides to "understand" cultures in terms of the "I. D. O." (Implicit Dominant Ontology) and the "Ethos" of each, he proceeds to work out the postulates and

the theorems of each culture in the best pseudo-scientific way, although his theorems no more follow from his postulates than the hunches of a horse player follow logically from the latest racing news. The result is guesswork clad in long flowing robes of gobbledygook.

An even easier way to introduce pseudo-science is to call any investigation "the testing of a hypothesis." This has the beauty that it is infallible. If a social scientist wants to find out whether rich people are more likely to vote Republican than poor people, he first "frames the hypothesis that there is a positive correlation between income and Republicanism" and then goes out and "tests the hypothesis." This can always be done, and it makes anything at all sound wonderfully scientific. If you want to find out whether your pencil is in the top drawer of your desk, you first frame the hypothesis that it is there, and then test the hypothesis. This is always verbally possible, but it reduces "hypothesis" to such a miserably feeble thing that all the highly-tooted virtues of the scientific method have been squeezed out of it. In an older tradition, still kept alive to some extent in the physical sciences (which are under no desperate compulsion to prove that they are scientific, because it is quite clear that they are), an experiment was regarded as "asking a question of Nature." If one

wanted to know the melting point of copper, one set up the appropriate apparatus for asking Nature the question, What is the melting point of copper? A social scientist would first frame the hypothesis that the melting point of copper is 1000°, then that it is 1001°, then that it is 1002°, and so on until he framed one right. A biologist, if he wishes to know how many toes a cat has, does not "frame the hypothesis that the number of feline digital extremities is 4, or 5, or 6," he simply looks at a cat and counts. A social scientist prefers the more long-winded expression every time, because it gives an entirely spurious impression of scientificness to what he is doing. Do tobacco smokers beat their wives? Call it "testing the hypothesis that there is a positive correlation between tobacco smoking and wife-beating" and it sounds so much better.

A social scientist called Stouffer made a very long investigation of the way people change apartments in Cleveland. But did he do this in the stupid, emotion-ridden way that a non-scientist would have done? No. Sublimely refusing to be guided by vulgar prejudice, he "considered various hypotheses which might constitute a generalized description of this behavior,"* and after much work and mathematics

* Lundberg: *Can Science Save Us* (New York: Longmans, Green & Co., Inc.) Reprinted by permission.

came to the conclusion that "the number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities."* In other words, people don't move any farther than they need to, but nothing is said about what direction they move in, whether toward a nicer or nastier part of town, or to be near some relative, or anything human like that. The same mathematical generalization was found to be true, with some modifications, for the United States as a whole, and for Sweden. And since the whole thing is put on the exalted plane of "making a hypothesis and testing its agreement with experiment" it has been regarded as a most praiseworthy application of the scientific method.

Wriggling this way and that in their efforts to describe what they do as Science, the social pundits will claim that at any rate their efforts permit *prediction.* And they are willing to be judged by this, for they regard prediction as the proof of the scientific pudding. Astronomy, one of the great pinnacles of the physical sciences, can predict the movements of a planet to a split second. On occasion, it can predict the discovery of new planets. The chemist can predict what will happen when he mixes two known

* *Ibid*

ubstances in a test tube, and on occasion the dis-
overy of new elements has been predicted. The
ocial scientist must needs do the same. If anyone
sks him to predict the movements of apartment
unters in Cleveland, he has the answer: "The num-
er of persons going a given distance is directly
roportional to the number of opportunities at that
istance, etc." And so, for a while, it may be. And
at any time people in Cleveland start moving the
rong distance, well, Stouffer's law has ceased to
old, that is all. It might require modification, as for
ne United States as a whole or for Sweden, or it
ight require more extensive change (or "reformu-
tion," to make it sound better). In any case, it will
e necessary to do the research all over again to find
ne new law.

The Nautical Almanac, that gives the positions
f all the stars and planets a year ahead, is the great
onument of prediction in the physical sciences.
avigators depend on it, and its reliability is alto-
ether admirable. Just compare it with a railroad
metable, to mention something in the social world:
e have to use the timetable, but there is always
e possibility, and frequently the actuality, that the
ins are not running exactly as scheduled. The
ight of prediction in the social sciences is the
tuarial tables of insurance companies. They give

very detailed predictions as to the number of peop
per 1000, that may be expected to die every yea
according to age, sex, occupation and many oth
things. They are very reliable as regards average
and this average reliability is quite sufficient for t
insurance companies to adjust the premiums so th
they can balance the books and make a profit. The
tables are the best that the social sciences can do, a
it is to be noted that the one kind of death predictio
which would be really important and worth doi
they cannot do. They cannot tell when any sing
person is going to die. All they can do, and all the
claim to do, is predict the death *rate;* and even th
they can only do within certain limits, for not a sing
insurance company can predict when the atom
bombs are going to make rubbish of every actuari
table in Hartford, Connecticut.

Now there is a standard excuse, current among th
social scientists, and also among many of the physic
scientists, condoning this inability of the soci
sciences to predict the death of one particular perso
although they can predict the death *rate* (with
limits). They base this on the Uncertainty Princip
of physics. They point out that physics has its unce
tainty, too; physics cannot make detailed predictio
concerning the behavior of *one* electron — they eve
wonder if it makes sense to say that there is suc

thing as *one* electron. Physics, too, makes average redictions, covering the behavior of a great many ectrons. There is always a tiny bit of uncertainty, ut since we never deal with less than billions of ectrons, and usually with billions of billions, the ncertainties don't matter, any more than the acci- ental death of one particular Joe Doakes has much fect on the death rate. They point out that even ysics would be quite different to an imaginary eing comparable in size with an electron. He would no means observe the beautiful regularity of New- n's laws of motion. He would observe very erratic ehavior, and he would only be able to formulate aws" by considering the statistical behavior of a eat many electrons. And so they say that the diffi- lty in the social sciences is nothing but this, that ey would like to be interested in individual be- vior, but that the scientific generalizations are only plicable on an average basis. This is a very com- rting thought, for a scientist, for it suggests that cial studies can be scientific, after all, and that eir subject matter is intrinsically as amenable to cience" as the physical world is. Unfortunately this ca is wrong. Electrons, although they may be atic, or even nonexistent individually, really do erage up in a predictable way. Men are quite ferent. They are unpredictable individually, and

they are unpredictable collectively, too. This i
because they have free will.

Not even free will daunts a dyed-in-the-woo
science fiend. "All I need to point out and establis
for scientific purposes," says Lundberg in *Ca
Science Save Us,* "is the great regularity and predict
ability with which men *will* things." * Oh really? A
occasional glance at "Manners and Morals," in *Tim*
magazine, may make a non-scientist question thi
In one city there was an epidemic of lipstick kisse
planted by the teen-age girls on statues, publi
buildings, curbstones, everywhere; in another plac
bobby-soxers took to rolling their socks so low tha
they could not be seen, although none of them knev
why they did it; in another place schoolboys too
to dyeing their hair green. This sort of thing i
reported every week. It does not resemble electron
in the least.

Such instances of the almost infinite unpredict
ability of man are known to the social scientists, bu
they are no more affected by them than the asylu
inmate is by being told that he is not Napoleon. The
simply say that these oddments of human behavio
are not important. This would hardly be a satisfac
tory excuse for a physicist, who aims to be able t

* Lundberg: *Can Science Save Us* (New York: Longmans, Green
Co., Inc.).

predict physical behavior, whether it is important or not. And the excuse is not even true: some unpredictable quirks of human behavior are extremely important. Did any social scientist predict, around 1920, the behavior of an obscure German ex-serviceman named Adolf Hitler? Has a religious movement ever been predicted? Religious movements start with just one person, who gains a few disciples; they often look, at first, like nothing more than silly fads; they are as common as waves of goldfish-swallowing, or propeller beany caps, and they are of tremendous importance.

It would be considered shocking by a social scientist to say that men have free will. But scientists can, if they will, see the difference between electrons and men very clearly. There are only so many things that an electron *can* do, and all the possibilities can be wrapped up in a sort of mathematical package of probabilities. No electron ever starts a religious movement, or even a fad among electrons. If men are as predictable as electrons, then a social scientist, to validate his claim, ought at least to be able to predict the next fad among social scientists.

Yet, "I can predict the will and the choices of man by exactly the same techniques I use to predict other natural phenomena,"* says Lundberg. And he con-

* *Ibid.*

tinues: "The same may be said about God. He is clearly a being with remarkably and demonstrably regular habits."* Here, it is clear, Professor Lundberg does not know what he is talking about. Even the law knows better; an act of God is, legally, "an event which no man could have foreseen."

The will and the choices of man are surprisingly complicated. One of the alleged cases of prediction in human affairs is traffic control: on Labor Day the police know well enough that there will be huge streams of traffic pouring out of the big cities, and they arrange to have officers on duty to deal with it. The traffic density, at various hours of the day, over the Triborough Bridge leading from New York City to Long Island can be predicted tolerably well. Not completely, because it depends on the weather. The weather can be predicted *more or less,* for a few days ahead, and this is sufficient to help the police officers in arranging their duty. How many cars will cross the Triborough Bridge on Labor Day of next year? To answer this, one would have to take into account the number of cars to be manufactured and sold by General Motors and the other companies, and this will depend on a number of factors, some of them human factors. We would also have to know what the weather will be, a year ahead. Now it may be

* *Ibid*

that knowledge of air masses and cold fronts will one day become so advanced as to make weather prediction a year ahead a possibility, but there are difficulties. The climate, and the weather, depend upon the degree of forestation. The degree of forestation depends on how many trees are cut down. It may be that at this moment, one or two human beings, lumber tycoons, are making a decision which will influence the climate of New York, and the number of cars passing over the Triborough Bridge on Labor Day of next year. To predict the decisions of these men a psychologist would be required, and it would be very difficult to find one qualified to undertake the job.

Social science depends on psychology. In order to understand the relations between men you must first understand men. We saw that psychology is a science, if it is one at all, only to the extent that it chooses to do without the most important way we have of understanding men, which comes from the fact that we are men ourselves. Social science, if it is to be a science, has an even further disadvantage, for what is the purpose of studying any phase of society (of "societal behavior," shall we say, to make it suitably long-winded), unless at the end you are going to say what should be done about it? By the official rules, a social scientist is not allowed to say

what should be done. Mr. Robert S. Lynd, the well-known author of *Middletown,* has recommended social scientists to take an actual interest in social questions, and recommend things. He has been rapped on the knuckles by some of the others for doing this. For as soon as you say what "should" be done, you cease to be a scientist. You become a citizen, that is to say a real person, which is much better. Science has abolished the words "should" and "ought." That is why we must never allow ourselves to be ruled by scientists. They must be our servants, not our masters.

Suppose that some vast social change takes place, let us say that America goes completely and successfully communistic. You wish to make a value judgment on this, to say whether it is good or not. Let us suppose that you are provided with an enormous army of ultra-efficient researchers: the first reports come in — "the material standard of living of every single person in the United States has been enormously increased." You still have to decide whether this is a good thing or not; you might even decide that it was an evil thing. The second reports come in: "But there is no individual freedom, even less than there was under the capitalist system." You again have to decide whether this is a good or an evil. The scientific method can do nothing except

give you the data; the good or evil of it has to be decided by methods entirely different from those of science.

In recent years there has been a spate of activity directed to putting "should" and "ought" back into science. They call it "the problem of *values*." The word sounds good, and it has an appealing uncertainty about it. If gold is valued by some people, you can either say that gold *is* a value, or that gold "embodies values." Similarly virtue, or beauty, or the like, may either be or embody a value, and in any case, only for some people, so that the whole thing is pleasingly "relative." Accordingly, this subject has immense appeal to modern scientists, and they deal with it in roughly three different ways, corresponding to three groups of people, the philosopher-scientists, the anthropologists, and a group who might be called the practical social scientists.

The philosophers write books. They are determined to find "should" and "ought" in science somehow, and they are determined in advance that the results shall lead to the conclusion that democracy is the best form of government. Some of them base their argument on evolution, some on "validating scientific experience," some of them do it in other allegedly scientific ways and all of them duly arrive at the conclusion that democracy is the best form of gov-

ernment. They do so by lines of argument so tenuous that only a very slight twist would be required to make them result in pure fascism. And one and all spin reams of highfalutin, abstract argument, without indicating, in any one particular case, how a genuine human decision can be arrived at. It is one of the major intellectual enterprises of our time, and it is doomed to failure. It amounts to an attempt to work out a system of ethics without God. All the learned books on the subject contain no more than an atheist can see about ethics, and that is nothing at all.

It is also the fashion to drag in the ghost of Aristotle, exhibiting him as evidence that it is possible to reach an ethics without God. He is an unsatisfactory witness for this point of view. Here is part of what he says, in his well-heard-of but insufficiently-read book on ethics: ". . . . The truth in practical matters is discerned from the facts of life; for these are the decisive factor. We must therefore survey what we have already said, bringing it to the test of the facts of life, and if it harmonizes with the facts we must accept it; but if it clashes with them we must suppose it to be mere theory. Now he who exercises his reason and cultivates it seems to be both in the best state of mind and most dear to the gods. For if the gods have any care for human affairs,

as they are thought to have, it would be reasonable both that they should delight in that which was best and most akin to them (i. e. reason) and that they should reward those who love and honour this most, as caring for the things that are dear to them and acting both rightly and nobly."* Poor Aristotle! He is derided for a number of mistakes he made in physics and in biology, but it is scarcely fair to throw him into the ethical record as an atheist.

The anthropologists, who deal with the problem of values rather indirectly, lead by far the most amusing lives. They go, first, to some interesting and inaccessible part of the world and live among the natives. Only when they return to civilization do they write books, and since they have something to say, they write much better books than the philosophers. They have found, by comparing notes on all the outlandish parts of the world that they have visited, that it is possible for human beings to live together under an extraordinary variety of conditions. Some tribes glorify and magnify sex, others pay as little attention to it as possible. In some tribes, a man will throw himself into a paroxysm of grief when a relative dies, in others, the whole thing is treated with extreme quiet and decorum. In some cultures, there

* From *Works of Aristotle Translated into English*, Oxford University Press.

are definite ways in which a man can go ritually mad, whereas others frown on anything so extreme as madness. It is commonly believed, and it certainly is quite plausible, that you could take a newborn Eskimo baby, bring it up in a Hottentot family (if the Hottentot family would take it), and it would be a Hottentot, or in a New York family and it would become a New Yorker.

Each culture is a consistent system; it would not work to take a bit from this culture, and a bit from that. When two cultures meet, they do not usually blend together to produce something better than either or even something intermediate. On the contrary, when white men reach some Pacific island, the native culture disintegrates, and the younger generation of natives are a great disappointment to their parents, by the standards of their culture, without being any great shakes by our standards.

The anthropologists, enchanted by their new discovery, are saturated with the idea of the variations between cultures. Polygamy is a crime in one culture, but the regular thing in another. Suicide, and the eating of human flesh, are ritually prescribed among certain peoples, but are abhorrent to others. Confronted by these bewildering variations, anthropologists are apt to say little about "should" and "ought," supposing that the facts will speak for themselves

for a sort of "relativity of morals" according to which nothing is either good or bad, but only in conformity with the prevailing customs. The only thing you must not do is anything that would prevent your culture from being an integrated system. Barring that, anything goes, for no culture is any better than any other. Prevalence of fornication is no bar to an integrated culture, therefore there can be nothing intrinsically wrong with it. Any change that may take place in our culture, provided it leads to a stable system, is quite all right. Nothing can be morally wrong, and by the same argument nothing can be morally right. And yet, there is reported to be a professor who gives a course in cultural anthropology under the title "Ethics."

Whatever the high theoreticians of science may say about value judgments, or the anthropologists leave unsaid about them, the practical social scientists deal with them in a very simple manner. When they remember their vows of objectivity (which isn't always) they get other people to make their judgments for them. It is unscientific, because unobjective, to make a value judgment yourself, but it is considered admirably scientific to record the value judgments of others, even though every single one may have been made as unscientifically as is humanly possible. This is because elaborate sampling tech-

niques, involving much mathematics, have to be used. In other words, they make use of the familiar tried tested and true Gallup poll.

Now it would be a mistake to underestimate the power of the straw polls, simply because they guessed the 1948 election wrong. The pollsters made a whopping mistake then, but at least they are capable of learning from their mistakes. Dr. Gallup has promised to mend his ways, and has been taking a Gallup poll to find out what was wrong with the first poll. The history of public opinion polls is one of steady improvement, and the forecast for the future is not that they will fade out, as a few people suggested in the first astonishment of Truman's victory, but that they will become bigger and better. They will never become infallible, but each time they get off the beam they will learn something new, and will go on better than before until some new gimmick trips them up. Quite possibly their future failures will be less spectacular than their last one. At any rate, the social scientists propose to rely on sample polls very heavily. Professor Lundberg has proposed a Public Opinion Laboratory, to find out what people think about the Marshall Plan, displaced persons, universal military service, sales tax, government aid for medical care, margarine versus butter, housing, cost of living, and everything else. "It may be," he says

in *Can Science Save Us,* "that through properly administered public opinion polls, professionalized public officials can give us all the efficiency now claimed by authoritarian centralized administrators, and yet have the administration at all times subject to the dictates of a more delicate barometer of the people's will than is provided by all the technologically obsolete paraphernalia of traditional democratic processes." * Which is gobbledygook for "let the polls run everything."

But who will run the polls? It is precisely here that we must watch the social scientists very carefully to see that they do not pull a fast one on us, or rather, that they do not bamboozle us into pulling a fast one on ourselves. As long as we have the "obsolete paraphernalia of traditional democratic processes" we can prevent ourselves from falling completely under the control of anyone but ourselves. Our democracy is clumsy, and admittedly it is not a "delicate barometer," but it is something of a powerful club, and a barometer was not made to be used as a club. If a politician does not do what we sent him to Washington to do, we can turn him out at the next election. What could we do to a pollster? He would be a "professionalized public official," and our control over

* Lundberg: *Can Science Save Us* (New York: Longmans, Green & Co., Inc.). Reprinted by permission.

public officials is very slim indeed. It is true that up until now there has been no suspicion against any of the well-known straw polls that they are consciously dishonest. It has been suggested that the unconscious preference of the poll taker may come out, but not, as of the present, that they are bribed. But then, they are only "straw" polls, in the sense that what they say has no official status. If political decisions were to be based on their results, we may well wonder how long this lily-white honesty would last.

Loud howls of protest arise at once, of course, from the science men if it is suggested that a whiff of dishonesty could attach itself, even in the future, to any poll taker. "Why, poll taking is a *science*," they claim indignantly, "and a scientist is by definition a person of the utmost honesty and integrity." Which is true, in a way, but it means that if a given person becomes subject to "bias" through powerful and subtle corrupting influences, he ceases to be a scientist, even though he may hold Ph.D. degrees from half a dozen universities. To argue the other way round is to argue from a word, a procedure which would be rejected with scorn by the same science men if anyone else did it.

Physical scientists probably deserve the reputation they enjoy for incorruptibility and unswerving

devotion to pure truth. The reason for this is that it is not worth while to bribe them. They may require some persuasion to use their talents for the destruction, rather than the welfare of mankind (during the war, many scientists were only brought into the atomic bomb work by the argument "If we don't get it, the Germans will"), but it is no use trying to tamper with the results of their work. The truths of atomic physics are what they are: if the scientists on the Manhattan Project had reported any other results than those they did, the bomb would not have worked. They were dealing with things, not with people. The "truths," if they are truths, of social science are nebulous and inconstant. Who really knows what he wants at any given moment? Can an inquiry from one of Elmo Roper's door-to-door researchers elicit a man's true thoughts? A very slight change in the wording of a question, or even in the tone of voice in which it is asked, can make all the difference to the response. For example, an official question such as "What is your attitude to Jews?" will bring an official answer, but if the interviewer then shuts his notebook and says, "Well, we're through with that stuff. Why don't you tell me what you *really* think about those dirty Jews?" an entirely different answer is often obtained. With such a degree of flexibility there are infinite possibilities,

and if any practical importance attaches to the answers, it would be well worth the while of a powerful pressure group to see that the questioners ask the "right" questions in the "right" tone of voice.

The glorious scientific future promises us more from the social scientists than from any other group. Mr. D. W. Hill hopefully tells us, in *Science — Its Effect on Industry, Politics, War, Education, Religion and Leadership:* "There is no outstanding problem between nations that the method of science could not solve at a hundredth of the cost of a major war." * Dr. E. U. Condon, formerly a member of the Atomic Energy Commission, said: "In short, the greatest contribution to real security that science can make is through the extension of the scientific method to the social sciences and a solution of the problem of complete avoidance of war." † Furthermore, war itself is merely a symptom of social tensions of various sorts and so, to prevent another war, it is necessary to eliminate, or at least reduce, the tensions between nations. But first we must find out what these tensions are, and here we come back to the techniques now so familiarly associated with Dr. Gallup and Mr. Elmo Roper. Pollstering is an article of export,

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† Reprinted by permission of *Science* magazine.

and there are straw polls in about a dozen different countries, such as England, Sweden, several countries in Western Europe, some of the British Dominions, and a few advanced countries in South America. Right after the end of the war, hopes were running high for this sort of thing, and S. C. Dodd proposed to the United Nations the formation of a Barometer of International Security, "to detect authoritatively and early the tensions that lead to war." There would be some difficulties, of course. The pollsters can hardly do their work with success in some Far Eastern countries, where a question is likely to be answered according to what the questioner wants to hear. They cannot report upon one very large country where the government does not permit them to enter. And it may be pointed out that even *if* Uncle Joe were to allow the most accurate polls to be taken of his subjects, so that we could know all their wishes and "tensions," we still would not know when a war would be likely to break out. For wars do not "break out" of their own accord; they are decided on by someone in authority. Any worthwhile information on a future war would have to include the secret counsel of the Politburo, and which social scientist can tell us that?

Social science has found a fine popularizer in Stuart Chase, author of *The Proper Study of Man-*

kind. Mr. Chase realizes the difficulties a little more clearly than some of the professionals. He sees that war is a deeply engrained institution in all societies except a few primitive ones, and that it is not likely to be exorcized by any glib formula. He calls for more and more scientific information of various kinds. "Area studies" are desirable, and he is pleased to note that "Russia is under examination by Columbia, Harvard, Yale, Stanford and the University of California." There should be an extension of "Kurt Lewin's controlled experiments on the amount of aggression in various forms of boys' clubs." He also takes into consideration such things as the world food supply, distribution of raw materials, Have and Have-Not nations. He calls for a team of political scientists, historians, psychiatrists, sociologists, anthropologists and psychologists, to be "usefully employed analyzing power relations on various levels."* He does not say what they will do with the results when they have got them. Will power really yield to an analysis? If Columbia, Harvard and the other universities confront Uncle Joe with their analysis of his power, will he pay any attention? He might say no to their suggestions. Alternatively he might *say* yes, and promise everything, but the following day he might take over another European country. The power relation

* Reprinted by permission of Harper & Brothers.

would then have changed, and there would be nothing for it but to do the analyzing all over again.

The problem of war is something more subtle than any social scientist can understand. As a problem in human motives, there is certainly no easy cure for it. Men are not angels, and the only reason science has not found this out is that science knows nothing about angels. A deep piece of wisdom was uttered on the Senate floor, in the course of the debate on inclusion of the social sciences in the proposed National Science Foundation, by Senator Willis: "It is a question of keeping selfishness in restraint, that is all." Senator Willis understands the problem of government, in all its simplicity and its tremendous difficulty. He is quite unlike any social scientist. That is why he is in the United States Senate, and they are not.

Chapter VII

TRUE SCIENCE — MATHEMATICS

THERE is one science, and only one, that is actually true. That is mathematics. The others, from physics downwards, do not lead to known truth, but only to probable opinion. It can of course be very highly probable. For example, it is extremely highly probable that the sun will rise tomorrow, or that if you let a ball out of your hand it will fall to the ground. But if you say, "There are no factors of 7," you can *know* this to be true. For many of the practical purposes of life the distinction between what is true and what is highly probable is not important, but there it is, and not all the purposes of life are practical purposes.

That the conclusions of physics are highly probable, but not necessarily true, has now been discovered by the physicists themselves. Gone is the firm faith and conviction of the nineteenth century that physics leads to *truth*. Even in the height of that arrogant period it was recognized by some philosophers — who were not able in that climate of opinion

to attract much attention, or to be thought of as "leaders" — that because a ball released from your hand a million times falls to the ground each time, is no proof that it will fall on the million and first occasion. "Science is based upon the belief that the universe is reliable in its operation" — and this remains a pure assumption, for we can never have any proof that the universe *is* completely reliable. None of the theories of physics can be proved, for it is never possible to say that every conceivable other explanation has been tried and found wanting. But if you want to find out whether the number 7 has any factors, you can try *all* the numbers below it — there can be no more than 6 of them — and see for yourself that none of them, except 1, will divide into 7 without a remainder. Thus in mathematics, but not in physics or the lower sciences, it is possible to *know* things.

But although in theory physicists realize that their conclusions are probable, perhaps highly probable, but not certainly true, this remains a piece of high theory with them, and does not really sink into their consciousness. Nearly all the time, in what they say and do and think, they forget their own theoretical conclusions, and act as if Science were indisputably True, and what's more, as if only science were true. They point to the derivation of the word, from *scientia*, Latin for "knowledge," in support of this

although if anyone else were to do this sort of arguing from the derivation of a word they would be dreadfully indignant. There was a time, away back in ancient Greece, when "science" meant "knowledge," such as mathematical knowledge, as contrasted with "probable opinion." But words change their meanings, as scientists are, on other occasions, the first to point out, and now the word "science" (or at any rate "physical science," which excludes mathematics) refers only to what is the result of that admirable old slog-horse, the scientific method. Thus "science" nowadays is probable opinion, not knowledge. Any information obtained otherwise than by the scientific method, although it may be true, the scientists will call "unscientific," using this word as a smear word, by bringing in a connotation from its original meaning, to imply that the information is false, or at any rate slightly phony. You must watch scientists carefully; they are wicked misusers of words.

The most "advanced" thinkers today (quite possibly the least reliable — just think of the advanced thinkers of yesterday) do their best to prove that mathematics cannot be known to be true either. They point out that our ideas of number, and of space (for geometry) are not, as was supposed by Kant, inherent pieces of our mental equipment coming from nowhere ascertainable, but are derived from the

senses. We would not be able to do mathematics if we had never had any experience of the physical world; therefore, they say, mathematics is fundamentally dependent on physics. They are sophists who say this, although they are most eminent philosophers in our most respectable universities. They seem to have an un-argue-out-of-able position, as is the manner of sophists, but this is no guarantee that they are right. You cannot be argued out of it if you maintain, with the eminent Bishop Berkeley, that nothing exists but your own sense impressions, but no one really believes this. Dr. Johnson refuted Berkeley by kicking a stone. That is the right way to deal with sophists. This stone *is* there, and you know this because you can kick it. There is a great temptation to kick the sophist, but it is not strictly necessary, kicking the stone will do. Alternatively, you can wait until the climate of opinion changes. Our advanced and fashionable thinkers are, naturally, out on a wide swing of the pendulum, away from the previous swing of the pendulum. If you want to reach dead center, you will do well to avoid the most advanced thinkers. Stay in the middle of the swing, and wait till the pendulum comes back to you.

Here is a way of seeing the characteristic difference between mathematics and physics. Take 4, and add 4, and again 4 (three of them altogether), and

you get 12. Take 3, and 3, and 3, and 3 (four of them altogether), and again you get 12. Elementary, my dear Watson, and nobody supposes otherwise. 3x4= 4x3. The sophists point out that you get this information, fundamentally, by taking three groups of four objects, and four groups of three objects; then since mathematical truth is derived from the behavior of physical objects, they say that mathematics is really a kind of physics, is dependent on the evidence of the senses, and shares the fundamental unreliability of physics. But there is a difference. Write down a number of 20 figures; if you multiply this by a number of, say, 30 figures, you would arrive at some enormous number (of either 49 or 50 figures). If you were to multiply the 30-figure number by the 20-figure number you would arrive at the same enormous 49-or 50-figure number, and *you know this to be true without having to do the multiplying.* This is the step that you can never take in physics, that of knowing something to be true without having to do a confirming experiment. In physics, no matter how many examples you get of what appears to be a generalization, you can never *know* that a new case will behave as the generalization says it should. Your conclusion is only very highly probable, and the generalization is no more than very nearly true. "Very nearly true" is not the same as "true," any more than getting somewhere

near the hole in golf is the same as putting the ball into the hole.

Of course you might get a calculating machine to multiply the 20-figure number by the 30-figure number. You could then tell it to multiply the 30-figure number by the 20-figure number. It would produce the same answer, as a matter of course, because it was made that way. There are calculating machines, recently built, of astounding complexity and ability, which will perform in a few hours feats of computation which would require years of work by a team of human computers. These machines always get the answer right, and always for the reason that they were made that way. It would be just as easy to make them give the answer wrong, for these machines have no understanding. They simply do what they are told.

You "tell" a machine what to do by pushing buttons, or by inserting a punched card, or a piece of wire magnetized in a certain way, or something of the kind. The machine makes electrical contacts according to the holes in the card, the circuits so closed actuate electronic tubes, which then actuate other electronic tubes, and so on through an astounding series of physical events. The end of it all is that the machine stamps out a punched card, or magnetizes a wire, in a certain way. Or else the machine is made

to print figures, which are symbols for numbers to the people who read them, though to the machine they are nothing but ink marks mechanically made on paper. It takes a human being to "tell" the machine what to do in the first place, and it takes a human being to read the figures (or the card, or the wire) at the end of the process. It is the combination human being plus machine that calculates. The machine by itself simply carries out mechanical and electrical operations according to its nature. If you took a bag, and dropped into it two stones, and then two more stones, would you say the bag calculates because at the end there would be four stones in it? The most elaborate machine ever made doesn't calculate any more than that bag.

One of the most fascinating recent developments in science is the discovery that machines, when they reach a sufficiently high level of complexity, begin to have queer resemblances to the human brain and nervous system. They even have similar diseases, and are sometimes cured by similar treatments, such as shaking violently, or passing a strong electric current ("shock treatment," this is called in the psychopathic ward). The "memories" that have been built into the machines sometimes go wrong, not forgetting when they are supposed to forget (the memory, a child once said, is "the thing we forget with"). A

mechanical memory may persist in grinding out the same stale information again and again, and Dr. Norbert Wiener, a theoretician of these machines, compares this to continued worrying, which he thinks is known in the terminology of another profession as the conscience. Some scientists have even seriously debated whether these machines think. These scientists think themselves, but they know nothing about thinking. When a scientist (or a "layman") calculates, he may or may not make marks on paper, but these marks are only to help him: the numbers are in his mind. No numbers ever enter the machine's mind, for the machine has no mind. All that enters the machine, and all that leaves it, are bits of paper or magnetized wires.

But if numbers don't enter the machine, where and what are they? The answer is, they are in minds (not brains) and exclusively in minds. Then they must be subjective and how horrible that must be for a scientist!

It is indeed horrible for scientists, who have no understanding whatsoever of the "subjective," as is scarcely surprising, since they refuse to pay it any attention. The general view of scientists is something like this: Everything can be divided into "objective" and "subjective"; "objective" comprises everything in the material world outside us, everything that we

can see, hear, feel, smell or taste, and "subjective" is our own thoughts and emotions. Nothing else exists, and even among these the "subjective" has only a thin and shadowy existence. It is further supposed by scientists that, as regards the objective world, we can all reach agreement, whereas the subjective world is a matter of "I like coffee, you like tea," so that no agreement is possible. They see everything in two classes, the objective, which is the same for everybody, and the subjective, which is a matter of taste (or "relative," as they would say). It is for this reason that they study only objective things, and when they do take a peek at the subjective, as psychologists have to do, they try to do it "objectively."

Alas, this neat division into two groups is entirely wrong. It is true about the objective world that we can reach agreement on it — more or less. The subjective world is not so simple. Part of it, certainly, is just personal questions of taste. Part of it, again, is numbers, for as we saw, numbers exist in the mind only. Nobody says, "For me, four times three is 13, but for you it may be 14." There is *no* disagreement about numbers, and that means that there is far less disagreement about them than there is about the "objective" world, which isn't always *exactly* the same for everybody. If you are looking for things about which universal and complete agreement really can be ob-

tained, it is only in the mind that you will find them.

Scientists like to define their terms, but mathematicians have realized that it is almost impossible to define some of their very simplest conceptions. If you try to give a really precise definition of a point, a line, or a straight line, you get bogged down in a morass of difficulties. Mathematicians can go in for very abstruse discussions of these ideas without arriving at satisfactory definitions. Yet the strange thing is that although points and lines are excrutiatingly hard to define, they are exceptionally easy to understand. Even rather dumb pupils understand them at once. The stupider members of a geometry class have all sorts of difficulties in understanding the propositions, and following the proofs, but these difficulties never depend on any serious misunderstanding of what a straight line is. They understand it as "just straight — that's all," and this utterly unscientific understanding is sufficient for complete agreement.

Euclid wrote a book on mathematics, more than 2,000 years ago, containing more than four hundred propositions. Every single one of these propositions is true. Some of his proofs can be severely criticized but no mathematician, alive or dead, doubts the conclusions. The propositions of non-Euclidean geometry are also true. They differ from those of Euclid but they are not in conflict with them because they

efer to different worlds. The Euclidean propositions efer to a world in which one and only one straight ine can be drawn through a given point parallel to a given straight line. There is a non-Euclidean geom- etry in which there are no parallel lines, and another n which there are many (through a given point paral- el to a given straight line). These geometries refer to heir own non-Euclidean worlds. Whether the world ve live in is Euclidean or not is a question for physics nd not for mathematics. The question is still open at resent, and if the answer to it, one way or the other, s ever found, it will be without effect on the truth of ll the geometries. Thus one good reason for study- ng mathematics is simply, and enormously, *because t is true,* a reason which is somewhat similar to, but nuch better than, that given by a mountain climber or climbing a mountain, "because it is there."

There was a time when mathematics teachers dim- y realized the great merit of mathematics and taught as if it were actually worth learning for its own ake. But although they did this, they did not give the ight reasons for doing it, and they taught mathe- natics in a dull, uninspired way, going through the notions of whatever had been done before. An merican college education of about a hundred years go was like this, and the class went through conic ections because it was traditional to go through

conic sections, without any clear realization of wh
educated men have studied conic sections since th
time of Apollonius. The most articulate expressio
of the *raison d'être* of the mathematics class wa
"mathematics is a valuable discipline," as if di
cipline in itself were what one gets an education fo
"Discipline," like "science," is a word that has the dr
husk of an obsolete meaning, which can be brough
in to confuse the issue. Originally that which wa
studied by the disciples of any teacher was a di
cipline, hence the traditional use of the word in edu
cation, although its present meaning is the snap-to
and-obey-orders that they put into you in the army
Our modern equivocators use the word to denote
particular study, but with connotations from th
army meaning, thus bringing in through the bac
door a vestige of the old idea that any study that
difficult and diagreeable is beneficial.

"Disciplinary value" is the last thing that a die
hard old fogy of an educator will claim for som
study that hangs on for no reason other than sens
less tradition. It was used in a last-ditch defense
Latin, to preserve the tradition according to whic
some hundred years ago, boys of twelve would be s
to compose Latin verse. Unable to think of any goo
reason for studying Latin — although there are som
good reasons — the old-fashioned classicists fell bac

pon "it is good discipline, it exercises the mind." This was finally scotched by some "scientific" measurements (at any rate, very systematic measurements) which showed that a boy who has studied atin is at no advantage, in studying some other subject, over a boy who has not. There is no "transfer" in ducation, this was held to prove. Otherwise one ould just as well solve crossword puzzles as study atin, it is just as good mental exercise, and extends he vocabulary too, and yet no one thinks of requiring his in school. One might just as well learn to play ridge, to develop the habit of making quick decisions: it has been shown that playing bridge helps he to make quick decisions — in bridge — but not in nything else. There is no transfer from bridge to nything worth while in life. This idea of "no transfer" was applied to mathematics, and the mathematicians, who ought to have known better, succumbed the argument, and let mathematics-for-its-own-ke go out the window. Instead, mathematics is now eated as a "service science," or as a "tool study," and studied merely for its usefulness in other sciences. nd yet there was a time when mathematics was lled "the queen of the sciences." Now it is their ndmaiden. How did it come to fall so low?

The decline of mathematics came about through e modern utilitarian philosophy, which regards the

sole purpose of science, of knowledge in general, an of education, as contributing to some "useful" pu pose. Even if we admit this attitude, we still have t find out what things are "useful." And useful fo what? We cannot answer this question throug science, and yet the answer to it is far more importa than any amount of scientific study. Just possibly w will be helped in answering this tremendously in portant question by studying a little mathematics fo its own sake. Intelligent men have thought so befo now.

Studying mathematics for its own sake isn't a que tion of "transfer." It isn't for any purpose that can b found by an examination test applied to the freshma class, with a parallel test given to the graduatin class to see how much they have improved (or rathe absorbed). The best purposes of education don work that fast, but go on through life, working wit an extremely delayed effect. It isn't even particular concerned with education for citizenship, for makin a good citizen is only one of the purposes of educ tion. Another purpose is to make a good *man* — whic brings us again to the tremendous question, What is good man? What would a good man do? Is it not a answer to say that he would pursue the true, th beautiful and the good? — for seriously, what else there that is really worth pursuing? Our schools pa

considerable attention to beauty, in an un-co-ordinated sort of way; they neglect the good almost entirely, and by their degraded treatment of mathematics they miss a fine opportunity to give some experience of the true.

The result of this is, as one might expect, deplorable. Graduates of our high schools and colleges lack the experience of actually *knowing* anything, of knowing it, and knowing the reasons. They do not even have the habit of wanting to know the reasons why they believe things. Their minds are crammed with information, but they prefer to believe it on a say-so, such as "science says —" or "science has shown that —" There are science teachers who actually claim that they teach "a healthy skepticism." They do not. They teach a profound gullibility, and their dupes, trained not to think for themselves, will swallow any egregious rot, provided it is dressed up with long words and an affectation of objectivity to make it sound scientific.

We have seen that the sciences arrange themselves in a scale, from physics at the top to the depths of the social sciences. Physics is at the top because it closely resembles mathematics. Physics can be, if properly taught, a magnificent training in logical thinking; it can even be a useful training in skepticism, provided the skepticism is applied to physics itself.

Physics is good science, but as the scope of the term "science" is broadened to include biology, psychology and the so-called social sciences, one by one the virtues drop out. Biology involves the study of a mass of detailed facts, which are related, not by logical thought but by grand sweeps of the imagination. Psychology cannot ask the important questions and to be scientific, it demands that we pretend not to know much of what we know, simply because our information comes by methods that are "unscientific" — as if that were synonymous with "untrue." And social "science" demands that we suspend the question, "What shall we do about it?" precisely in those matters in which "What shall we do about it?" is the most important qusetion. What is there in common to all these that gives our educators such faith in "the widening spread and deepening hold of the scientific habit of mind?" What is this habit of mind?

Boiled down to its essentials, the habit they mean is the habit of making unbiased judgments. They wrap it up in flowery phrases, often of outstanding vagueness. Thus James Harvey Robinson, whose sonorous essay "The Mind In The Making," trumpeted pan-scientific ideas at the beginning of the 1920's, called for "a general frame of mind" and a "critical openminded attitude."

If this is the attitude of mind that is wanted, the question at once arises, Is it science that should be studied in order to achieve it? Why not study law? A judge has to do everything that a scientist is exhorted to do in the way of withholding judgment until all the facts are in, and then judging impartially on the merits of the case as well as he can. An advocate presents either side of the case to the best of his ability, without regard to where his own genuine opinions lie; surely practice in doing this should develop a most commendable elasticity of mind, which would be helpful in understanding the other fellow's point of view, and in first seeing, then eliminating, your own prejudices. In education for citizenship law has the immense advantage over science that it actually relates to citizenship. If there really is no transfer, as the scientists themselves would have us believe, unquestionably law is the thing to study.

As another suggestion, to practice scientific deduction by logical thinking, without preconceived notions, why not a course in Sherlock Holmes? The detectives, or at least the detective-story writers, join with the scientists in excoriating "dogmatic prejudice, lying, falsification of facts, and data, and willful fallacious reasoning," as Professor Hendren of Georgia puts it. Let everybody take a stiff course

with the dicks, and then just possibly there would be somewhat better thinking in social, political and economic affairs, for a dick has to be as coldly judicial as a scientist, and as scientifically impartial as a judge.

But our scientific educators do not do things in either of these ways. Their recipe for achieving their high aim is "first year one biological science, second year one physical science," or any of the corresponding formulas. A college graduate who has "had" a little bacteriology or acoustics is supposed to be helped thereby in becoming a better citizen. It is believed that this experience will help him in eliminating what is called "prejudice" or sometimes "bias," these words being used as namby-pamby expressions for race hatred, or its milder form, race dislike. Yet it ought to be obvious that science has nothing to do with our likes and dislikes. The scientist is impartial in examining all the facts, and he is (or should be) zealously impartial in considering whether his theory fits the facts or not, but this has nothing to do with his liking or disliking the object of his study. Does an entomologist have to like his insects? A parasitologist is as impartial as anything while he is determining whether a disease is due to a virus or a rickettsia, and transmitted by a mosquito or a louse, but as soon as he has found

the cause of the disease his attitude becomes one of complete partiality, and he does all he can to stamp the disease out. He has a "prejudice" or "bias" against disease. A nutrition chemist, once he has discovered a new vitamin, will not be impartial about it, but will do what he can to see that we all get it in our food. Science may tell us anything it can find out about the Russians, that they breathe the same air as we do, that their cranial capacity is the same (or smaller, or larger, however it may be), but all this information will not prevent many people from regarding the Russians as a menace. Science may be able to find out many things concerning labor unions: it may even reach the conclusion that they will result in less money in the pockets of the rich; if this is so, most rich people will oppose the labor movement whether they have had scientific training or not.

It is not likely that "bias" is appreciably reduced even in professional scientists. Suppose that a Negro family moves into a house in the street in which you live. Suppose, too, that one of the houseowners in the street is a scientific professor, a specialist in the pigmentation of the salamander. It is just possible that the admirable objectivity with which he regards pigmentation will "transfer" to the Negro, and that his scientist, in his attitude toward the matter, will be markedly different from his neighbors. But it is

also extremely likely that he will show just as much "bias" as anybody else. He may have an eye on real-estate values, and he may be among the first to join a committee to force the Negro to go back among "his own people." This is in accordance with the scientific finding that transfer of any particular skill will take place only to something very closely related; in this case there might be transfer from a salamander just about as far as a tadpole, but no further.

Still less is it likely, and it is certainly not observable, that millions of people who have been exposed to a few spasmodic science courses during their education will develop that "critical open-minded attitude" toward the important political problems on which, as citizens, they will have to make up their minds. The specialist scientist has at least spent years of his life practicing all the scientific virtues (such as they are) in his own little hole and corner. The college graduate has done a handful of experiments in which, perhaps, he was able to use the scientific method himself; he has spent yawning lecture hours listening to encomiums on the scientific method, and he has crammed from a textbook an array of facts which allegedly were found by this highly-touted method. For a very small proportion of these facts, optimistically estimated at one per cent, he has some idea of how they were found out,

and of how splendidly open-minded their original discoverer must have been. For all the rest, he has simply been *told* that some praiseworthy scientist has been open-minded about them, and he has just about as much experience of actually exercising this virtue as someone who has merely read Izaak Walton's *The Compleat Angler* has of casting a fly.

Even the professional scientists themselves take their objectivity the easy way. For they practice objectivity on objects, where it is not in the least difficult, and they pat themselves on the back outrageously for doing it. It is really not so hard to be objective about anything so unemotional as the chemistry of the hormones or diastolic pressure or the physiology of the nervous system. If you want to eliminate your own prejudice about genuine human problems the thing to do is to study just that, genuine human problems, preferably ones that are right in your home town; find out what your prejudices are and do your best to eliminate them. You will also have to decide what should be done about the problems, and go ahead and do it. The thing not to do is to look through a microscope at an amoeba and kid yourself that it is going to improve your judgment of social problems. It isn't. It won't help more than an amoeba's breadth. Worse still, it may fool you into thinking that you have achieved something when

you haven't. In this way, science is not the best thing to study, but the very worst.

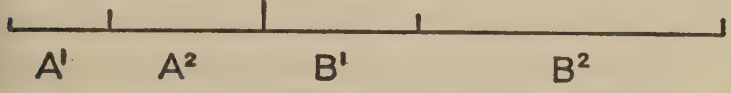
But mathematics, as opposed to the rest of "science," is really worth while and important, although the reasons for this are not very easy to see in our modern scientific climate of opinion. It is necessary to go back even before Aristotle, to Plato, who has an uncanny knack of being right where other people are wrong, and is probably a more reliable guide than the advanced thinkers of today. The highest truths can only be expressed in the form of myth, and Plato has expressed great truths about mathematics and about science in a mathematical myth, the Myth of the Divided Line.

Unfortunately, translations of Plato are customarily made by specialized "classics" men who know no mathematics. Over the door of Plato's Academy was written, "People who don't know geometry not admitted." Some of the translators would not have been admitted, and they translate the Divided Line so badly that no one can understand it, and in consequence it is even omitted in some of the popular editions of *The Republic*. Readers of these truncated versions have to make do with the parallel myth the Myth of the Cave, and they miss the experience of seeing how mathematics can be made the basis of the highest poetry for the purpose of conveying

truth. The Myth of the Cave has always been very popular, for it is more striking and dramatic than the Divided Line (it "has higher literary values," as if anything "literary" were the right reason for reading Plato), but it does not have the same depth of meaning, for it is not based on mathematics.

Plato's famous line is divided into two unequal parts, like this:

Each of the parts, A and B, is now divided again, in the same ratio:

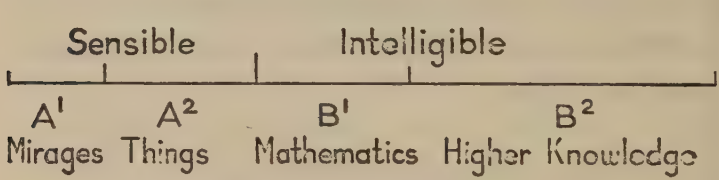


A simple consequence of this is that A^2 is equal to B^1. Plato doesn't point this out explicitly, and the translators are apt to miss it, but Plato's students had all passed their geometry examination, and could see it for themselves.

Now comes the myth. The shorter part, A, is the "sensible," B is the intelligible. A is anything that we can see, hear, feel, smell or taste, in other words, material objects, the realm to which scientists confine

their attention. But it is not intelligible. If you thought that you could *understand* material objects you were mistaken.

Both the "sensible" and the "intelligible" are broken down again like this:



The little section A^1 is made up of things such as mirages, hallucinations, and things that we see when "our senses deceive us." A^2, a little more important, is "real" things. B^1, the lowest division of the intelligible, is mathematical objects, numbers and lines and figures and the like. Remember that B^1 is equal to A^2. This expresses the fact that mathematics can be made to "fit" the world of material objects. This fitting of B^1 to A^2 is precisely what the scientist does.

But our scientists stop at the end of B^1 and that is what is wrong with them. Beyond B^1 lies B^2, the largest and best section of all. Mathematics is essential, but it is not really to be studied for its own sake, nor because it is "useful," and not only because it is, in its own limited way, true, but because it can be used as a steppingstone to the really important

knowledge in B^2. Try this. It isn't so crazy as it sounds. Give it a thorough trial — for at least several years of your life.

The highest section of the divided line has been labeled in this book "higher knowledge." What Plato has to say about it can be read in any *good* edition of *The Republic,* but he is a little vague and hard to follow. This is because, although he was a superb philosopher and poet, he was only an indifferent theologian. But even an indifferent theologian is better than a modern scientist. Time was when a scientist was apt to be a definite atheist. Now, there are some scientists, such as the late Lecomte du Noüy, who have set out to make God respectable among scientists. Many scientists go to church, but since they keep Sundays and weekdays in thought-tight compartments, they have neither a definite theology nor even a definite atheology.

Scientists have no notion of what goes on in the upper section of the divided line. Consequently they do not know what science is truly for. They think in terms of "pure" science, pursued "for its own sake," and "applied" science, for the material benefit of man. There are many scientists who think that applied science is all that counts, and that "pure" scientists, if there are any, are just ivory-tower men. They are entirely wrong in thinking this, and they

miss the main point. The first purpose of science is to learn about God, and admire Him, through His handiwork. If any usefulness comes in – as it does in large quantities – why, so much the better. If scientists looked upon their work in this way, they would cease to worship Science, and they would be the better scientists for it. And incidentally, they could then develop a sense of humor about science, and this would save them from making themselves, so many times, so very ridiculous.

Chapter VIII

WATCH THOSE SCIENTISTS

"WHAT SCIENCE may *do for men* is not enough. This must become subordinate to what science may *do to men,*"* said Otis W. Caldwell, late general secretary to the American Association for the Advancement of Science.

The prospect of what science may *do to men* is horrible. So, too, are the atomic bomb, radioactive poison gases and biological warfare, but in a different way. These terrors of the next war are well known to everybody, and most of all to scientists, and the scientists are more anxious than anybody else to prevent them from ever being used. There are also dangers from science that are very much more subtle, and come from the fact that scientists are completely unaware of them.

We have seen how science begins with physics, the science of sticks and stones. What should be the higher sciences, dealing with plants and animals,

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and with men either individually or collectively, are actually lower than physics, because they insist upon using the methods of stick-and-stone-ology upon live subject matter. They can't ask the right questions, they don't know how to get the answers, and they can't tell us what to do with the answers when they have got them. And since it is *these* people who have a position of extraordinary prestige among us, although they know so little that is worth knowing, we must watch them very carefully, for they are not to be trusted to do anything either for men or to men.

Here is a little story about a scientist, to illustrate what they don't see. In the world-renowned aquarium of Naples, a friend of mine met a scientist who was engaged in experiments on fish. He had them attached by string to a device which made a record of their tail movements. Some of them were entire fish, others had had portions of their brains removed. The brainless fish made smooth regular curves on the recording instrument, but the tails of the untreated fish made distressingly irregular movements. The scientist was delighted with this discovery. "See," he said, "it is the higher brain centers that *disturb* the basic movement pattern of the muscles. The brainless fish make beautifully regular movements." This scientist was unable to see any sort of connection between what he was doing in the aqua-

rium and what was going on around him in Italy, where Mussolini made the trains run regularly, but did not allow anyone to think a single thought that was contrary to the ideas of his regime.

This scientist was an ichthyologist, and therefore his own experiments were harmless (except to the fish). Other scientists are more ambitious. Lancelot Hogben, in *Science and the Citizen,* speaks of "the social programme of discovering how the human brain can be regulated or how social institutions carry on." * I wouldn't trust my brain to be regulated by Hogben or any other scientist.

One of the marvelous discoveries of science is "brain waves." They are detected by an electrical device strapped over the head. They are very useful in diagnosing epilepsy, and they are intensively studied by scientists, trying to find out what happens inside the mind. Up to the present, scientists have not tried to regulate these brain waves, or to change them. If ever they do, we must keep a sharp eye on them. For since, as we saw before, science can tell us nothing about what is good or bad, and since scientists have not been trained to think any other way than scientifically, they have nothing but their own half-baked ideas to go on in deciding *whose* brain waves are to be changed, and what to change

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them to. And although scientists pretend that they know nothing, as scientists, about what we should aim for, but only about how to achieve whatever we decide to go for, in practice they have a very simple way of deciding what *should* be done. Unfortunately, it is a very bad way.

It might work like this, in the case of brain waves (or if it were not brain waves, it might be hormone secretions, or something else). First, some scientist would announce the discovery of a new type of brain wave, irregular like the tail tracks of the unaltered fish, and occurring in only a small percentage of the population. It would be called an "abnormal" pattern, because it would differ from the average. An average is always sacred to a scientist. Next, some psychologists would investigate all the people who had the "abnormal" waves, giving them intelligence tests, Rorschach tests, motor coordination tests, integration of personality tests, emotional scale valuations, and the whole psychological works. They might find in most of these people what they would describe as serious emotional maladjustments. They would say that these were caused by the irregular brain waves, because the brain waves were discovered first. (If the emotional disturbances had been discovered first, they would have been the cause of the brain waves; this is the way scientists

think, in practice.) Next, the social scientists would step into the picture. They would consider the actions of the irregular brain-wavers "in their social context," or "with their societal significance." They might find that these minority people did not accept the social valuations of the community, and what's more, they might even be persuading other, normal, people to join them in their aberrant ways of thought. If what they were thinking happened to coincide with whatever particular "ism" was being witch-hunted at that moment, the stage would be set for the last, and very sinister, development. The neuro-psychiatrist would be called in, or perhaps the psychosomatic physician, and he would fix up some very simple "cure," which would make them in all scientifically-observable respects like the rest of the population, and restore them to that glorious ideal, the average.

And yet, what if the average itself were wrong? Modern life in this country is highly unnatural. Machines, telephones, radios, vitamin pills, subways, cars, trains, airplanes, elevators, injections, television and, in the near future, Geiger counters, all products of science, and all intended individually to help us, collectively harry us day and night and drive us to stomach ulcers or the psychiatric ward. Isn't it entirely possible that most of us are driven slightly

crazy by it all? Is it not plausible, and even likely, that most of us have the wrong kind of brain wave? And if so, what happens to the sacred average? It may be that in our modern society more people are nuts than not. The scientists, in their worship of the average, would be using their great powers not to cure anything, but instead to make sane people mad.

Another marvelous but sinister invention of science is the lie detector. It does not literally detect lies; it detects emotional changes, such as a catch in the breath, and changes in the blood pressure and heartbeat when making the little effort required to sustain a falsehood. The subject sits, with a cuff round his arm to record blood pressure and pulse rate, a tube round his chest for rate of respiration, and electrodes on his left hand for electrodermal response (or psychogalvanic reflex). He is required to answer a list of questions, beginning with innocuous ones, the nasty ones bearing on "who dunnit?" being slipped in later. The same list of questions is given three times over, and a twitch in the various records is not considered significant unless it occurs at the same place all three times. It is not easy to fool the machine, but neither is it entirely foolproof. In any case the results have to be interpreted by a specialist, and a specialist is very uncomfortable to have against you in a law court, because you cannot

meet him on his own ground. Lie detectors have been admitted in court many times, when both parties agreed to their use. If either party objects, the evidence obtained from them would probably be ruled inadmissible, but the legal status is not entirely cleared up. Some of the scientists engaged in these matters (but not all) consider the lawyers a bunch of slowpokes for not rushing to accept the wonderful findings of science. Thus, for the immunity from compulsory lie detecting which we enjoy at present, we can thank lawyers rather than scientists.

Even worse than the lie detector are the truth drugs, sodium amytal, scopolamine and some others. With the lie detector you cannot conceal the fact that you are lying, but under the influence of these horrible drugs you cannot lie at all, and you cannot even stop yourself from speaking. What's more, you have no recollection of it afterwards, and you have no idea what you told them. You may have betrayed all your friends to the secret police, and you do not even know about it. The same drug can also be used for good, of course, and it has done wonderful things for psychiatric cases. It enables a battle-shocked soldier to talk out his secret fears, and get rid of them. The drug itself is neither good nor bad; it depends entirely on the use that is made of it. Scopolamine is a harmless drug, the scientists say, but what is their

idea of "harmless"? Since they have, as scientists, no conception of good and evil, and since they have never tried to do any thinking outside of scientific thinking, their stunted imaginations are limited to the idea of *physical* harm. "Scopolamine is a harmless drug when administered correctly. A series of individuals were awakened five hours after its use, no worse for the experience. They ate and enjoyed a hearty breakfast."* So, in the traditional account, did the condemned man just before he walked to the electric chair. The phraseology of scientists can be very revealing. "Under its influence the subject does not have the ability to make up a lie or follow through in a deception."† Note the use of the word "subject," as in a kingdom, or under a tyranny; not "citizen," as in a republic; not even "patient," as in a hospital.

In this Republic, not yet science-crazed, we enjoy immunity from truth drugs, officially at any rate, and the same goes, generally, for countries on this side of the Iron Curtain. On the other side, they may, for all we know, have drugs far worse than are known here, and for all we know, they may make free use of them. These horrors are things that we have been

* *The Human Frontier*, by Roger J. Williams (New York: Harcourt, Brace and Company, Inc.).

† *Ibid.*

spared so far. We must pray to God, and also do everything possible ourselves, that we may continue to be spared. Perhaps these things will never come upon us, they may belong in that capacious rag bag of What Science Hasn't Done Yet. But scientists appeal so often to what they haven't done that the layman may be excused for an occasional use of the same appeal.

Even in the realm of practical politics, there is already plenty of reason for watching scientists very carefully. We are the less inclined to see this on account of a widespread belief that the progress of science is closely connected with democracy. This belief is held and fostered by scientists themselves, but, in spite of what they say, science has very little to do with democracy. The argument that there is some connection between the two barely amounts to more than this: "We like Science, and we are in favor of it; we like Democracy, and we are in favor of it; therefore they are the same thing."

But science and democracy differ greatly, both in regard to what they are aiming at, and in regard to how they go about things. The aim of science is truth. The aim of democracy is the best kind of government. As we saw before, science does not reach the truth: neither does democracy in practice ever achieve the best in government. At any rate, science *aims* at truth,

while democracy aims at justice or political expediency. Truth is a matter of whether things *are* this way or that: politics is a question of whether we *should* do this or the other, having in mind what is best, either for the individual or for society, and science can no more help us decide what is best than a locomotive can take the place of a compass.

As the aims, so also the methods of democracy are entirely different from those of science. The most typical instrument of democratic methods is the ballot box. Democracy means a state of affairs in which the laws are made, directly or indirectly, by a vote open to all the people or of a substantial majority of them. The word also has a great many connotations, which vary from one person to another, so much so that semanticists, who delight in having things confused, have tried to convince us that "democracy" has no meaning. But to anyone who can distinguish between a denotation and a connotation, the meaning is still clear enough. Science, being a matter of reproducible experiments and of theories applied to the facts by the use of reason, is entirely different, although one would hardly think so from hearing or reading what scientists say and write. They frequently go according to "what most experts believe —" or "the consensus of expert opinion —" or "the understanding of the leading specialists —" When they do

this, what they are doing is science in name only, just as in some countries there is democracy in name only. Genuine science does not proceed, as democracy does, by counting heads, even if they are heads of departments at universities.

Science can flourish under any kind of government that is favorable to science, and therefore it can flourish in our kind of democracy. We can have both democracy and science too. But they are not the same at all, and we are inclined to think of them together on account of a historical accident. The nineteenth century was a period of terrific expansion of science; it was also a period of great extension of democracy, and this is about the only justification for those who think that science and democracy are almost synonymous. But in strict scientific method, all we can conclude is that, in this period, science and democracy were associated with one another. It would be most unscientific to conclude either that science caused the democracy, or democracy the science. And it is worth noting that the twentieth century, in which democracy has been if anything on the wane, has so far been a period of even greater expansion of science. The Germans didn't get the atomic bomb; but their V-2 was taken up avidly by our army. Their chemists are still, as they have been for 100 years, magnificent, and there was an unseemly scramble between Ameri-

can authorities and the Russians to get the top-flight German scientists.

The most alarming scientists, naturally, are the worst — the social scientists. The typical instrument of the social scientist is the straw poll, and this has the *appearance* of being exceedingly democratic. However, as we saw before, it is important to know who runs the polls, and we have less control over a pollster than over a politician.

Straw polls have been objected to many times, but usually for the wrong reason. It has been questioned whether it is legitimate for an organization to ask a great many people how they propose to vote, and publish the results. The political pollsters sell their results to the newspapers, which publish them as "news." The newspapers are doing nothing different from what they used to do in pre-Gallup days, when reporters would be sent out to interview "the man in the street"; they are only doing it more systematically. If it is legitimate, before deciding how you are going to vote yourself, to ask a few of your friends how they will vote, then it is legitimate to ask a great many people, or to have a public opinion organization do this for you. The questions asked in a political straw poll are entirely proper. It is different in other types of survey, if the questions asked are improper. This is the case in Dr. Kinsey's famous investigation. You

may decide your vote after asking other people, but you do not regulate your sex life by asking your friends what they do in bed. Impertinent questions are just as impertinent when they are asked in the name of science.

Objections to straw polls have also been based on another wrong reason, on the assumption that their prophecies tend to bring about their own fulfillment. The election of President Truman in spite of the prediction of an overwhelming Republican victory has made everybody doubt this. Politicians find the straw polls rather puzzling; in their trade it is customary to say not only "Vote for my party" but also "My party is likely to win," because to say otherwise would be to admit the shadow of a doubt, and the politician thinks that he would get no votes unless he showed himself bursting with confidence. As it is now, the politicians do not know whether to say "The polls predict a victory for my party — therefore vote for me" or "The polls predict a victory for the opposite party, but remember the election of 1948 and vote for me." Up until now politicians have thought of elections in terms of jumping on the band wagon, as if people voted so as to be able to say "I voted on the winning side." At the national party conventions jumping on the band wagon is a well-known habit, for there the voting is open, and everyone is afraid of

losing patronage if he goes on record as having voted against the winner. But in the national election the voting is secret, and it looks as if the American public behaved exactly as one would expect a free, rational people to behave. The Republicans were told Dewey was certain to win. So they were lazy and didn't bother to go to the polls. The Democrats were told it would be extremely difficult for their man to win. So they made a real effort, and he *did* win. The moral of all this is, pay no attention to the straw polls. Whatever they say may be wrong, and politicians will have to learn to live with them and like it.

The real objection to straw polls, apart from the question of who runs them, is that they tend to be altogether too scientific. Elmo Roper, in his valiant efforts to find out why he went wrong in 1948, spent six months of painstaking work trying to find out what happened on November 2 of that year. The votes had all been duly counted, objections by the official scrutineers had been ironed out, Truman had gone back to the White House, and Dewey to Albany, but Roper wanted to know, ward by ward, exactly how the election had gone. He wanted to be able to make a scientific analysis, so that he could say whether labor voted this way, or the farmers that way, or the rich for such a candidate (it turned out to be Dewey) or the women for whomever it was. He

experienced great difficulty in getting at detailed facts, and he was surprised and utterly pained at this. "As a result of the chaotic state of our fact-gathering facilities in this country in the field of election statistics, we have had to obtain information from individual boards of elections scattered over the land.... In one state we had to persuade the governor to help us personally!"* Anyone would think the entire election was staged for the purpose of providing Mr. Roper with the information he craves. The 1948 election was, as it should be, a secret election. Let us hope that all our subsequent elections remain secret, and are not opened, or even partially opened, in the name of social science.

At present, most of the social scientists who call themselves Scientists receive their funds through institutions attached to universities. They complain greatly that they do not receive sufficient funds, for their ambitions are more grandiose than can be satisfied out of the bare cupboards of an institution of higher learning. At any rate, money from universities is probably about as nearly uncontaminated as money can be, although even at that it is not entirely free from the wishes and desires of the rich men who contributed the money in the first place, as is well known to anyone who remembers Upton Sinclair's

* Reprinted by permission.

The Goose Step. To be able to realize their larger projects social scientists will have to become less squeamish about the source of their endowments. They must tap some large source of Big Money, rather than rely on the puny streams that trickle through the partially sterilizing filter of a university.

Now there are only two sources of Big Money: Big Business (or Foundations, which are Big Business at one remove), and the Government.

Henry Ford II has pointed out that his famous grandfather spent millions of dollars in scientific research, as ordinarily understood, without spending any comparable sum on the problems of employees and how to keep them happy in their jobs. There are wide-open possibilities here, whether it is Ford or anyone else who takes them up. "Market research" is of course a commonplace, and represents the harmless and even beneficial type of social research. But why should it stick to that? Industry has long ago learned that science, at any rate the old-fashioned kind, pays for itself handsomely. The Bedeaux system was an early example of the sort of thing that is now dignified by the name of science, and the new science lends itself admirably to organized snooping under the impressive names of "social engineering" or "biotechnology." There is a real and dreadful prospect that social scientists will find well-heeled sponsors for

work on "the problems of employees." They will make every employee not exactly happy, but happy *in his job*. He will be permitted to stay happy as long as he stays in his job, but woe betide him if he betrays a trace of that old-fashioned feeling, a longing for independence.

But if it may be undesirable that social scientists should receive funds from the XYZ Company or the International Enormity Corporation, would it not be entirely appropriate for their projects to be sponsored by the Government? There are reasons for thinking that this, too, may have its dangers. Mr. Aldous Huxley has seen them very clearly. "The most important Manhattan projects of the future," he prophesied, will be vast government-sponsored inquiries into what the politicians and the participating scientists will call 'the problem of happiness' — in other words, the problem of making people love their servitude."

Social scientists see things differently from Mr. Huxley, and are not much concerned about freedom or servitude. In *Survey of Social Science*, by Marion D. Smith, Professor of Sociology at Louisiana State University, it is interesting to note that "Freedom" does not appear in the index. Neither does "Liberty," though "Libraries" is there. However, a short discussion of liberty and freedom can be found in the text, as a subsection under the heading "Regulations."

Milton wrote the *Areopagitica,* a defense of freedom of speech, John Stuart Mill wrote his famous essay *On Liberty,* to mention only two illustrious authors who have contributed to this ancient subject, but they were pre-scientific. Patrick Henry made his famous declamation "Give me Liberty, or give me Death!", but a social scientist, being a scientist, is not allowed to declaim anything at all. Give me Patrick Henry every time.

"Verbal behaviors that are not means to ends are of little sociological significance. Although they may indicate social disequilibriums, the rebellious mutterings of the slave . . . are of no importance unless they lead to actions."* This is from *Sociology,* by Professor R. T. Lapiere, of Stanford University, and it means that if slaves can be kept from acting, what they say or think doesn't matter! This alone is enough to show why the science-mad social scientists should never be allowed to be in too close association with our government. We Americans, having won our liberty from a tyranny less than 200 years ago, still prize it very highly. Our Constitution provides an elaborate system of checks and balances, designed to prevent the Government from becoming too powerful. We are justly suspicious of anything that tends to make the Government even more enormous and e-

* Courtesy of McGraw-Hill Book Co., Inc. Copyright 1946.

aborate than it is now. An abstract thing like liberty s a little difficult to see for a "scientist" who culti- ates objectivity, particularly if he is so gosh-darned bjective that he thinks there is no such thing as nought, only "verbal behaviors."

If a scientist became really objective about free- om, he would not even be able to say what it is. He ould notice that the word "freedom" seems to con- ey different things to different people: to us, free- om of the press means freedom from interference y the Government; to the Russians, it means free- om from interference by the capitalist cartels. The ussians are astonished at our fear of a government hich, according to our own political theory, we lected ourselves. A scientist should have no difficul- in understanding this argument, but it is much ore difficult for him, with his objective methods, to nderstand our deep suspicion of a civil authority at stands above all other authorities, even if we did ut it there ourselves. Objective science cannot de- ribe to us the feeling of the backwoodsmen in the ontier days — probably the freest men there ever ere — when "every man was as good as any other, d a darned sight better." Mr. Lyman Bryson, mak- g a great scientific effort, defines a free society as ne in which there is a rich variety of normalities"*

* Reprinted from Lyman Bryson, *Science and Freedom.* Copyright 7 by Columbia University Press.

— which will be all right, until the shock troops or th commissars come in saying, "There isn't a rich enoug variety of normalities around here; some of you hav got to do something different." Still more objectiv and still more dangerous, would be the conclusio that, since "freedom" is understood differently b different persons, it is only a subjective feeling, state of mind. What causes this subjective feeling Obviously, the "conditioning" (or "education") tha the person has received. A Russian thinks of freedo differently because he was conditioned differentl that's all. Anybody is free who thinks he is free, a cording to his past conditioning. The scientific co clusion would then be very simple: Condition every body alike, and give them, instead of freedom, wha ever they have been taught to think of as freedom To make the whole thing easier to carry out in pra tice, it will be well to condition people to think of, a freedom, something that will be easy to provide fo them. Bread and circuses, for instance, or nice T programs. This is the ultimate conclusion from th scientific method, strictly and objectively applie and if scientists ever persuade politicians to advo cate it, then we can say good-bye to freedom.

When Galileo dropped two weights from a towe in Italy (it was *not* the leaning tower of Pisa, excep in the schoolboy legend) he did not know what h

was starting. He started the modern science of physics. He also, according to the official account, started the modern scientific method, and that has gone a long way since Galileo, and a long way away from physics. The further science has gone from physics the worse it has become, without, however, sacrificing any of the reputation that physics, and physics alone, comes near to actually deserving. And not only worse, but also funnier. We must watch scientists carefully, to see that they do not put anything over on us — to see that we do not learn, by personal experience, what science can *do to men.* But while we are watching them, we can get a great deal of amusement. We can, and should, laugh out loud at scientists, and this will be the very best way to prevent them from regulating us, or averaging us, or conditioning us to synthetic happiness. For what are they doing? The most laughable thing in the world. They are all crowding round and bowing low before a Sacred Cow.

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